208 PLAN

Cape Cod Area Wide Water Quality Management Plan Update

Cape Cod Area Wide Water Quality Management Plan Update
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CAPE COD
COMMISSION

Prepared by the Cape Cod Commission
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Plan Summary

Updating Section 208

This report documents an update to the 1978 Section 208 Plan for Cape Cod. In a January 30, 2013 letter, the Massachusetts Department of Environmental Protection directed the Cape Cod Commission to prepare an update to the 1978 Water Quality Management Plan for Cape Cod to address the degradation of Cape Cod's water resources from excessive nutrients, primarily nitrogen.

In 1978 the plan identified increasing residential densities and a three-fold summer population influx as the cause of isolated water quality and wastewater management problems. It anticipated that future growth threatened to cause more serious groundwater contamination and increased eutrophication in surface waters. Today, the region is facing the impacts of that growth and working to maintain the environmental integrity that is so vital to the economy of this special place.

Cape Cod has a water problem. The saltwater border that has defined our peninsula is being poisoned by nitrogen. The rapid decrease in the water quality of Cape Cod's marine ecosystems is plain to see. The problem is nitrogen and the largest controllable source is the septic systems used every day.

For over a decade the Massachusetts Department of Environmental Protection (MassDEP), the Cape Cod Commission (Commission) and the Massachusetts Estuaries Project (MEP) at the University of Massachusetts-Dartmouth have worked with the 15 Towns on Cape Cod to research and diagnose the problem. In January 2013 the Commonwealth of Massachusetts used the Federal Clean Water Act and directed the Commission to update the 1978 Section 208 plan for Cape Cod. The designation and direction were accompanied by a short time-frame and a focus on nitrogen.

Massachusetts saw the opportunity to use this approach on Cape Cod as a way to combine the independent efforts underway and develop strategies and investigate new technologies and policies to address the looming environmental and economic crises.

The Commission worked with hundreds of people across the region and filed a draft Section 208 Plan Update in June 2014. MassDEP and US EPA reviewed the draft and it was offered for an extended period of public comment in August that closed in November 2014.

THE PROBLEM

Nitrogen is impacting coastal water quality. About 80% of the nitrogen that enters Cape Cod's watersheds is from septic systems. The conditions it creates destroy animal habitat and result in frequent violations of water quality standards indicated in part by fish kills and diminished shellfisheries. The Cape Cod seasonal economy relies on the water that surrounds the region and the degraded water quality is negatively impacting important economic drivers including coastal property values. Restored coastal water quality is an environmental and economic imperative; however, the current planning and regulatory environment makes it difficult for communities to identify cost effective, implementable solutions.

Plan Summary

TOTAL MAXIMUM DAILY LOADS

HOW MUCH IS TOO MUCH?

A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDL's are technical planning documents and are not, in and of themselves, enforceable documents requiring compliance. Federal, state and local authorities implement TMDL's by incorporating the limit as part of other enforceable legal instruments, such as Massachusetts groundwater discharge permits in the case of some nonpoint sources of pollution or National Pollutant Discharge Elimination System (NPDES) permits in the case of NPDES-regulated point source discharges. TMDL's are useful in quantifying goals for reducing or eliminating pollutants that degrade conditions in a waterbody measured qualitatively as fishable and swimmable by the federal Clean Water Act.

As detailed below, the Commonwealth and the University of Massachusetts School for Marine Science and Technology (SMAST) established the Massachusetts Estuaries Project (MEP) which has been working to determine the maximum amount of nitrogen Cape Cod marine ecosystems can accept without becoming eutrophic.

THE COST OF DOING NOTHING

Cape Cod's water resources drive the regional economy. They attract visitors in the summer months and make the Cape a desirable place to live for year-round and seasonal residents. Continuing and increasing nitrogen loading of Cape Cod's embayment watersheds will further degrade coastal water quality, adversely impacting environmental, economic, and societal norms. The economic impact of doing nothing to restore coastal water quality will be significant, affecting every homeowner in the region.

3VS

The Cape Cod Triple Value Simulation (3VS) model is one resource being developed to consider the broader environmental and societal costs of environmental degradation. As a sustainability assessment tool, the 3VS model applies systems thinking to the problem of nitrogen pollution in Cape Cod embayments. Phase 1 of the model will estimate the potential social, economic and environmental costs of not taking action to mitigate projected increases in nitrogen loadings to Cape Cod embayments. Phase 2 of the model will include a comparison of policy intervention scenarios to evaluate direct and indirect costs and benefits of different potential actions to reduce nitrogen loadings. The 3VS model incorporates data sets from around the country to estimate costs associated with inaction.

Case Study: Three Bays

THREE BAYS: ESTIMATED IMPACT OF NITROGEN ON PROPERTY VALUES

A study evaluating home prices in the Three Bays area in the Town of Barnstable was conducted to test the hypothesis that water quality degradation resulting from nitrogen pollution impacts single-family home sale prices negatively. Single-family properties within 1,000m or about 10 minutes walking distance from the waterfront comprise the study area. The model estimates the impact of water quality – nitrogen levels – on home sale prices, controlling for property attributes, macroeconomic influences, proximity to public beaches, distance to water. The time period of the analysis is between 2005 and 2013.

Initial findings demonstrate a 1% increase in nitrogen is associated with a decrease in single-family home sale prices in the range of 0.407% to 0.807% (average 0.61%), with a 95% confidence level. During the study period the water quality in Three Bays degraded by 15.8%. The above range of estimated decrease translates into a noticeable fiscal impact on the community, both in terms of decrease in sale price and consequent impact on the assessed value.

Case Study: Three Bays cont.

For example, if the discharge of nitrogen into Three Bays waters was lessened resulting in a 3% decrease in total nitrogen level, average single-family home sale prices in the study area would have been $16,774 to $32,957 higher than in 2013. That translates into potential sale value loss (and consequent assessed value loss) in the range of $49 to $86 million in the study site alone (1,000m or ten-minute walking distance to the waterfront). No action in 2015 will bring additional loss of home value to Cape Cod due to degrading water quality from nitrogen.

Cape Cod's environment is linked directly to its economy. The nitrogen problem is a significant threat to both. Continued degradation of the coastal resources on Cape Cod will negatively impact the seasonal and year-round economies, affecting property values for year-round residents and second homeowners, and shifting property tax burdens away from higher value seasonally occupied coastal properties on to middle class year-round residents.

Cape Cod – Defined by Water

UNDERSTANDING THE PEOPLE AND THE PLACE BEFORE CONSIDERING SOLUTIONS

A glacial deposit created Cape Cod as a peninsula with Cape Cod Bay to the north, Nantucket Sound to the south, the Atlantic Ocean to the east, and a significant part of the western coastline bounded by Buzzards Bay. With the construction of the Cape Cod Canal circa 1914, the land mass became surrounded by water. Cape Cod has 560 miles of coastline, nearly 1,000 kettlehole ponds and a sole source aquifer.

LAND USE

Cape Cod's great natural beauty, bountiful recreational opportunities and proximity to major urban areas led to a rapid increase in population over the last half century. The Cape's traditional farming and fishing way of life underwent a slow transformation from the 1870s through the early part of the 20th century as seaside resorts began to attract summer visitors. The advent of rail travel and the adoption of the interstate highway system added to the accessibility and the popularity of Cape Cod. The population began to rise more quickly in the 1950s and even more steeply from the 1970s through the early 2000s, as Cape Cod became a desired location for retirees and second-home buyers. Most of this development was residential with associated commercial, industrial, and tourism-based land uses.

In the past several decades the number of people living year-round on Cape Cod increased, with a concomitant conversion of seasonal homes for year-round use. The 2010 US Census listed about 57,000 seasonal housing units, or approximately one third of the housing stock on Cape Cod. These seasonal homes are much more prevalent in coastal areas than inland on Cape Cod.

Balancing natural and human-built systems remains both a challenge and an opportunity. Open space in more sensitive areas improves the ability of the natural environment to further absorb human impacts as well as counteracting naturally occurring uncontrollable nitrogen loads from atmospheric deposition. Conversely, sprawling patterns of growth tend to increase infrastructure costs and make the delivery of services such as public transit less practical. The location of infrastructure and public facilities, and zoning support and drive land use patterns. The development of infrastructure, from wastewater to telecommunications, will be essential to regional economic growth that doesn't degrade the human or natural environment.

Plan Summary

WATER RESOURCES

MARINE WATER

Watersheds define the jurisdiction of the nitrogen problem.

Cape Cod is defined by and dependent on the marine environment that surrounds it. Nutrients and pollutants from land use development, including wastewater, are conveyed through groundwater to surrounding marine waters with concentrations and directional flows determined by watersheds.

Similar to water supply wells, watersheds to embayments are defined by groundwater flow paths of the aquifer. There are 101 watersheds to the surrounding marine waters. Of those, 53 are watersheds to coastal embayment systems, or partially enclosed coastal areas with varying degrees of tidal restriction. Coastal embayments are located at the margin of the aquifer and are the ultimate receiver of the aquifer's groundwater discharge.

Watersheds to coastal embayments extend from the coastline up to the top of the water table lens, located along the spine of the peninsula. They comprise nearly 79% of the land area of Cape Cod. The remaining land area is comprised of watersheds where groundwater discharges directly to open coastal water such as the Cape Cod Canal, Nantucket Sound, Cape Cod Bay and the Atlantic Ocean. These areas may be important to local nitrogen removal, remediation and restoration efforts given their decreased nitrogen sensitivity.

GROUNDWATER

The hydrogeology of Cape Cod is largely composed of coarse sands with considerable permeability. The travel time for wastewater pollutants from their initial entrance into groundwater to the point when they reach an embayment can be up to 100 years, but is less than 10 years across almost half of the region. This presents the likelihood that wastewater treatment options, once implemented, will result in water quality improvements within 5-10 years in some of its polluted embayments.

The Cape Cod Aquifer is one of the most productive groundwater systems in New England and provides 100% of the Cape's drinking water. It is a sole source aquifer providing drinking water to over 650,000 people during the peak tourist season and is derived from 158 gravel-packed municipal supply wells providing public water service to 85% of Cape Cod, and hundreds of private wells providing service to 15% of Cape Cod in the communities of Sandwich, West Barnstable, Eastham, Wellfleet and Truro. The aquifer is recharged from rain and ultimately conveys that water to the surrounding embayments, if not otherwise captured by wells and groundwater-fed ponds.

The Cape Cod Aquifer is extremely susceptible to contamination from various land uses and activities. The aquifer has been seriously impacted in the past from military activities, gas stations, landfills and other activities. The quality of Cape Cod's community public drinking water supply is generally very good, but over the past 15 years there has been a trend toward some degradation.

PONDS

The lakes and ponds on Cape Cod formed about 12,000 years ago during the last stage of the Wisconsinan glaciation. As glaciers retreated from Cape Cod, large chunks of ice were left behind. As these chunks of ice melted, the landscape above them collapsed, forming large depressions called kettle holes. Where these depressions dip below the groundwater table, they are filled with water and create the hundreds of ponds that exist on Cape Cod today.

Cape Cod has 996 ponds covering nearly 11,000 acres. These ponds range in size from less than an acre to 735 acres, with the 21 biggest ponds making up nearly half of the total Cape-wide pond acreage. Approximately 40% of the ponds are less than an acre. One hundred and sixty six are designated as great ponds of 10 acres or more.

Cape Cod's freshwater ponds are fragile systems especially vulnerable to pollution and human activity. The key nutrient of concern for freshwater ponds is phosphorus. Water quality in Cape Cod ponds is significantly impacted by surrounding development. A comparison of 1948 and 2001 dissolved oxygen concentrations suggest that many of these pond ecosystems are not only impacted, but also seriously impaired.

The fresh water ponds of Cape Cod provide a significant benefit in removing nitrogen as it moves through the watershed. Ponds provide natural attenuation of nitrogen in groundwater and are an important consideration in watershed planning, as they act as "nitrogen filters."

Existing Regulatory and Planning Framework

Water quality goals for the nation, the state, municipalities, districts and specifically for Cape Cod are reflected in a number of laws, regulations and plans, some regulating the problem and others focused more on the regulation of proposed solutions that can be identified in two categories – regulating the problem and regulating the solutions. The federal Clean Water Act and the state Title 5 regulations focus on the problem. The Massachusetts Environmental Policy Act, the Cape Cod Commission Regional Policy Plan and other local ordinances impact the siting of potential solutions on Cape Cod.

REGULATING THE PROBLEM

CLEAN WATER ACT

The US EPA regulates water quality under the Federal Water Pollution Control Act of 1972 and its subsequent amendments in 1977, 1981, and 1987. Collectively these are known as the Clean Water Act. The objective of the act is to maintain and restore the chemical, physical and biological integrity of US waters. The act requires states to establish ambient water quality standards for water bodies based on the need to protect the use(s) designated for that water body.

The Act regulates point sources under the National Pollutant Discharge Elimination System (NPDES) permit program. In most cases, the NPDES permit program is administered by authorized states on behalf of US EPA. Massachusetts is one of a handful of states that is not a delegated NPDES permit state; however, permits are jointly issued by the US EPA and the MassDEP and are equally and separately enforceable by both agencies.

Point Sources

The definition of a point source of pollution as stated in §502(14) of the Federal Clean Water Act is "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged."

The Clean Water Act authorizes US EPA and states to regulate point sources that discharge pollutants into navigable waters of the United States through the NPDES permit program. These "point source" discharges are generated from a variety of residential, municipal and industrial operations, including treated wastewater, process water, cooling water, and stormwater runoff. The NPDES Stormwater Program regulates discharges from municipal separate storm sewer systems (MS4s), construction activities, industrial activities, and those designated by US EPA due to water quality impacts.

Nonpoint Sources

The term "nonpoint source" is defined as any source of water pollution that does not meet the above legal definition of a "point source." Nonpoint sources are typically described as those emanating from precipitation that has picked up natural and human-made pollutants as it moves over and through the ground. The US EPA lists fertilizers,

herbicides, pesticides, oil and grease, sediments and bacteria, and nutrients from "faulty septic systems" as examples of nonpoint source pollutants.

MASSACHUSETTS SURFACE WATER QUALITY STANDARDS

Following the federal law and as prescribed by the Federal Clean Water Act, the Commonwealth of Massachusetts adopted surface water quality standards for individual water bodies. The standards designate the most sensitive uses for which the water body must be "enhanced, maintained, and protected" (whether or not the designated use is currently attained), prescribe minimum water quality criteria necessary to sustain the designated uses and contain the regulations necessary to achieve and maintain the designated use and, where appropriate, prohibit discharges.

Massachusetts divides coastal and marine surface waters into three classes: SA, SB, and SC, in descending order of the most sensitive uses that water body must attain. Additionally the state has special designations of Outstanding Resource Waters, Special Resource Waters, Shellfish (waters), and Warm Water.

IMPAIRED WATERS AND TOTAL MAXIMUM DAILY LOADS

The Clean Water Act, under s.305(b) , requires states to assess the quality of surface waters based on the designated uses biennially (every 2 years) and to develop a list, referred to as the 303(d) list, of impaired waters—those waters that do not meet the designated uses. The most recent impaired waters list for MA, including Cape Cod waters, is the Massachusetts Year 2012 Integrated List of Waters; however, a draft 2014 list is also available. Under §303(d) of the Clean Water Act, states are required to:

- Identify those water bodies that are not expected to meet the Surface Water Quality Standards; and,
- Establish, subject to US EPA approval, for those waters total maximum daily loads (TMDLs) - a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards.

On Cape Cod, state-developed TMDLs are based on technical reports prepared by MEP. TMDLs are formulated by MassDEP and submitted to the US EPA for approval after public comment.

TITLE 5

MassDEP regulates wastewater flows less than 10,000 gallons per day under 310 CMR 15.000: The State Environmental Code, Title 5: Standard Requirements for the Siting, Construction, Inspection, Upgrade and Expansion of On-Site Sewage Treatment and Disposal Systems and for the Transport and Disposal of Septage (typically referred to as Title 5). Most of Cape Cod's development is regulated by Title 5. Only 5of the 15 municipalities on Cape Cod utilize centralized collection and advanced treatment. Title 5 covers such uses as conventional on-site septic systems, alternative systems, such as denitrifying systems (often called "Innovative/Alternative," or I/A, systems), as well as composting toilets and other kinds of systems in use on individual properties or cluster developments. Title 5 presumes residential wastewater flows at 110 gallons per day per bedroom (e.g., Title 5 presumes that a four-bedroom house will generate 440 gallons per day). Non-residential wastewater generation is typically based on use and square footage, or the number of restaurant seats.

MassDEP may identify certain areas as particularly sensitive to pollution from on-site wastewater systems and therefore require the imposition of loading restrictions. These Nitrogen Sensitive Areas (NSAs) include:

- Interim Wellhead Protection Areas and department-approved Zone IIs of public water supplies
- Areas with private wells

- Nitrogen-sensitive embayments or other areas, which are designated as nitrogen sensitive under Title 5 based on appropriate scientific evidence

The nitrogen-loading restrictions in NSAs apply to new construction only and do not affect existing Title 5 systems unless they are deemed to have failed or are required to be upgraded at the time of property transfer. To date, MassDEP has been reluctant to designate NSAs on Cape Cod because they don't solve the problem..

GROUNDWATER DISCHARGE PERMIT PROGRAM

Flows in excess of 10,000 gallons per day are regulated under the state Groundwater Discharge Permit Program. Systems requiring a groundwater discharge permit require significant removal of nitrogen because the Cape Cod Aquifer is designated as a non-degradation resource. Groundwater discharge permits for Cape Cod require an effluent treatment level of at least 10 milligrams per liter of nitrate, which is almost a two-thirds reduction in the amount of nitrogen leaving a septic system. In the last 10 years, groundwater discharge permits for projects located in watersheds to impaired embayments have been held to a "no-net nitrogen" standard by MassDEP. This means that any nitrogen released into the watershed must be "offset" by the removal of nitrogen from an existing source. To date, this typically occurs by connecting a nearby existing development to remove nitrogen via wastewater treatment.

REGULATING THE SOLUTION

COMPREHENSIVE WASTEWATER MANAGEMENT PLANS

Currently, individual municipalities develop Comprehensive Wastewater Management Plans (CWMPs) within town boundaries. These plans include watersheds that are both wholly within town boundaries, and shared with a neighboring town(s). MassDEP considers requests for municipal permits and financing after the state level environmental scoping review is conducted under the Massachusetts Environmental Policy Act (MEPA).

The MassDEP Division of Municipal Services Guide to Comprehensive Wastewater Management Planning outlines the process for development of a CWMP. According to the guidance, "The planning exercise requires a community to perform a needs analysis: identifying problem areas."

CWMPs have traditionally recommended conventional wastewater sewer collection and treatment facilities, which require groundwater discharge permits and sewer construction permits.

MASSACHUSETTS ENVIRONMENTAL POLICY ACT AND OTHER STATE REGULATIONS

Comprehensive Wastewater Management Plans typically require MEPA review prior to state and regional permitting. MEPA review involves scoping proposed projects for their potential environmental impacts, identifying alternatives, and avoiding, minimizing or mitigating environmental impacts. CWMPs are typically filed first as an Environmental Notification Form (ENF) or Expanded ENF with a Draft Environmental Impact Report (DEIR) and released for public comment. At the end of public comment, the Secretary of Energy and Environmental Affairs will issue a Certificate of Adequacy that outlines additional information or analysis that should be conducted prior to the next MEPA filing. The final MEPA filing is a Final Environmental Impact Report (FEIR). Upon the Secretary's issuance of a Certificate of Adequacy for an FEIR, appropriate state agencies and the Cape Cod Commission then commence their regulatory reviews. In addition to MassDEP regulatory review, other state agency permits may include: Massachusetts Natural Heritage and Endangered Species Program; Massachusetts Historical Commission; Massachusetts Division of Marine Fisheries, and others.

REGIONAL POLICY PLAN

The Cape Cod Commission Act (Act) established a Commission regulatory function to review and approve, condition, or deny development projects that exceed Development of Regional Impact (DRI) thresholds. The Act includes a provision that the Commission develop and implement a Regional Policy Plan (RPP) that contains the minimum performance standards (MPS) for its regulatory

review of proposals. The Commission published the first version of the Regional Policy Plan in 1991; it has been updated and revised every five years. All revisions to the RPP are approved as ordinances by the Barnstable County Assembly of Delegates, the regional government's elected legislative body.

A Development of Regional Impact is a proposed development that is likely to present development issues significant to more than one municipality in Barnstable County. Projects are referred to the Cape Cod Commission for review as DRIs by a variety of means.

Municipalities are typically required to file an Environmental Impact Report (EIR) with the MEPA Unit for the development of CWMPs. The Cape Cod Commission Act (§12(i)) requires that the Commission shall review as a DRI any proposed development project for which the Massachusetts Secretary of Energy and Environmental Affairs requires the preparation of an EIR. As a result, the Commission conducts a regulatory review, generally concluding with a written approval decision containing findings and conditions for all CWMPs proposed by Cape Cod towns. CWMPs typically trigger EIR review because they involve construction of a new wastewater treatment and disposal facility with a capacity of 2,500,000 gallons per day, or because they result in construction of one or more new sewer mains 10 or more miles long. CWMPs may also trigger mandatory EIR thresholds for land and wetland alterations, impacts to endangered or threatened species or archeological sites, and other factors.

The Commission's regulatory review of a CWMP is presently guided by the planning guidance and minimum performance standards of the Regional Policy Plan. The pertinent technical sections of the RPP include water resources, open space, natural resources, planning and historic preservation. Some of the requirements are similar to MassDEP requirements, but some are quite different.

The 2009 Regional Policy Plan changed the "no net" policy to reflect the newly adopted TMDLs by MassDEP and US EPA as the critical nitrogen loading limit. The performance standard interprets the adopted TMDL as a "fair share." The fair share is the TMDL equivalent load to be allocated to contributing towns on a per-acre rate using the watershed and sub-watershed area.

LOCAL REGULATION

Local zoning, board of health regulations and conservation commission regulations also often impact the selection and siting of wastewater treatment technologies and approaches.

What Is Being Done?

MASSACHUSETTS ESTUARIES PROJECT

In 2001, MassDEP and the University of Massachusetts School for Marine Science and Technology, in collaboration with the Cape Cod Commission, established the Massachusetts Estuaries Project.

MEP scientists developed models that link nitrogen loading in a watershed to coastal water quality. Inputs into the models include data on coastal water quality, tidal flushing, bathymetry, pond water quality, current and historic eelgrass coverage, water use, wastewater treatment plant performance (if any), landfill monitoring, watershed delineations, sediment nutrient regeneration, and nitrogen attenuation from wetlands, rivers and freshwater ponds. The modeling results confirmed earlier studies identifying on-site septic systems as the major source of nitrogen to coastal embayments.

In response to concerns raised by some Cape Cod communities regarding the validity of the MEP scientific approach, the Barnstable County Commissioners directed the Cape Cod Water Protection Collaborative (Collaborative) to undertake a scientific peer review of the MEP process. In 2011, the Collaborative organized an independent scientific peer review of the MEP methodology for developing appropriate TMDLs for the estuaries and embayments of

Cape Cod, and for the use of that methodology as a basis for wastewater and nutrient management planning and implementation on Cape Cod. The scientific peer review process was independent and objective, and operated externally from the Collaborative and from any other Cape Cod stakeholders.

The peer review panel found the MEP modeling approach to be appropriate and useful for evaluating alternative scenarios and informing nutrient management plans, and also found the MEP to be consistent with existing nationwide TMDL practices. The panel also found that the MEP modeling approach is scientifically credible, and the modeling approach is consistent with current understanding of existing conditions for Cape Cod estuaries, based on available data. The components in the approach are well known and documented. Computation of watershed nitrogen loads is strongly data-driven and quantitatively linked to estuarine nitrogen concentrations.

The MEP partnered with Cape Cod communities to evaluate coastal water quality and develop technical reports recommending water quality targets for nitrogen that MassDEP utilizes to develop TMDLs. Model results are presented in published technical reports, and identify one potential scenario indicating how much nitrogen must be removed from wastewater to meet the water quality target in a particular coastal embayment.

The MEP was estimated to cost $12 million over six years. Funding is broad-based with half coming from the state and the other half coming from local and other agency sources. Barnstable County, through the Cape Cod Commission, provided over $700,000 to the MEP over the last eight years as direct assistance to participating Cape Cod towns. The MEP's regionally consistent methodology provides technical work and documents at significant cost savings over towns undertaking similar work individually.

The MEP developed a rigorous Linked-Model approach that includes components of the various disciplines necessary to understand and project how nonpoint source nitrogen loading in a watershed translates into coastal water quality deterioration. Data input into these models includes: three years of volunteer-collected coastal water quality data, tidal flushing data, bathymetric information for estuaries and freshwater ponds, pond water quality data, current and historic eelgrass coverage, water use information, wastewater treatment plant performance, landfill monitoring data, watershed delineations, sediment nutrient regeneration, and wetland nitrogen attenuation.

Embayments on the southern coast of Cape Cod are typically more susceptible to impacts because the tidal range is generally 1/2 to 1/3 of the range observed in Cape Cod Bay to the north.

As of February 2015, 35 watersheds have completed MEP technical reports, two are in draft form, and four are pending.

The MEP provides specific documentation, based on water quality testing, that many of Cape Cod's watersheds have impaired water quality and ecological damage due to nitrogen loading. Nitrogen from septic systems accounts for approximately 80% of the watershed load, with stormwater and fertilizers accounting for the remainder of the locally-controllable nitrogen load. Atmospheric deposition of nitrogen in rainfall is another source accounted for in the stormwater runoff contribution for the watershed and as direct rainfall on the embayment itself.

The MEP technical reports and TMDLs contain estimates for how much watershed nitrogen needs to be removed to meet the TMDL. Since septic system contributions represent the greatest controllable nitrogen load in Cape Cod watersheds, TMDLs also specify how much wastewater nitrogen from septic systems would need to be removed to meet the TMDL. The average removal rate for septic nitrogen load to meet water quality standards exceeds 50% Capewide.

Plan Summary

CAPE COD COMMISSION

Concurrent with the beginning of our awareness about coastal waters, the Commission adopted a regulatory requirement that development projects within watersheds to water quality impaired embayments should have no-net nitrogen loading. In other words, the amount of nitrogen added by the project must be offset by an equivalent reduction. Several County-appointed committees that reviewed the Commission's regulatory program accepted this requirement as a necessary interim step to halt continued degradation of the Cape's coastal water quality. Over the years, it became increasingly clear to organizations involved in assessing and protecting embayments that a comprehensive effort to link regulatory and scientific activities was necessary to realize solutions for observed coastal water quality problems.

POND AND LAKE STEWARDSHIP

In 2001 a coalition of groups interested in protecting ponds received a $30,000 grant to develop a Cape Cod pond stewardship strategy from the Massachusetts Watershed Initiative, known as the Ponds and Lakes Stewardship (PALS) project. The Cape Cod Pond and Lake Atlas, published by the Cape Cod Commission in 2003, provides a status report on the PALS program. It documents the outreach and education activities leading to the creation of the PALS program, reviews water quality data collected by volunteers during the 2001 PALS Snapshot from over 190 ponds, uses this data to develop Cape Cod-specific indicators of pond impacts, reviews data collected in previous studies, and details further efforts necessary to move pond protection and remediation forward on the Cape.

BARNSTABLE COUNTY HEALTH DEPARTMENT

MASSACHUSETTS ALTERNATIVE SEPTIC SYSTEM TEST CENTER

The Massachusetts Alternative Septic System Test Center opened in 2000 to research and test advanced on-site wastewater treatment systems. The Center is operated by the Barnstable County Department of Health and the Environment (BCDHE) and is located at Joint Base Cape Cod. Although the Center's initial emphasis was on nutrient-reducing technologies, more recently it conducted research on the efficacy of commercial and soils-based septic systems for removal of pharmaceuticals and personal care products. The Center has been instrumental in forming and conducting many internationally recognized standards for both secondary and tertiary wastewater treatment. Ancillary projects include the support of research efforts on wastewater diversion techniques, such as composting toilets and urine diversion, and their efficacy for addressing the nutrient management issues in sensitive watersheds.

The majority of the systems tested at the Center are proprietary systems and the efficacies of non-proprietary denitrification strategies are less understood, primarily due to the lack of financial incentives to develop and promote them. It is clear, however, that Cape Cod communities are interested in exploring all options available to reduce nitrogen that enters the groundwater. Through this update of the Section 208 Plan for Cape Cod, funding was provided to the Barnstable County Department of Health and the Environment to investigate non-proprietary means to remove nitrogen by enhancing and/or manipulating soils-based systems.

INNOVATIVE/ALTERNATIVE SEPTIC SYSTEMS PERFORMANCE TRACKING

More than 1,500 innovative/alternative (I/A) septic systems have been installed on Cape Cod in an attempt to reduce the amount of nitrogen discharged into the groundwater. These systems range in their complexity, but all require regular maintenance and monitoring. Since 1999, BCDHE has maintained a database to assist regulators in the task of tracking performance and adherence to maintenance schedules. Regular performance and compliance updates are provided to local regulatory boards. More recently, to aid the public and engineering professionals, the department has created an interactive tool to chart performance of all technologies used within Barnstable County. This tool assists wastewater planners to

develop realistic performance expectations, thus facilitating accurate CWMPs. Occasionally printed compendia of the information are distributed to local boards and commissions. The department also maintains training tools to instruct boards of health regarding the proper application of these technologies.

COMMUNITY SEPTIC MANAGEMENT LOAN PROGRAM

The Barnstable County Department of Health and the Environment initiated the Community Septic Management Loan Program to assist homeowners by defraying the costs of septic system upgrades through provision of 20-year betterments. More recently the program has assisted in providing support for the actual connection costs to centralized systems or combined packaged or cluster treatment systems. Barnstable County administers this program regionally for all Cape Cod towns.

CAPE COD WATER PROTECTION COLLABORATIVE

The Cape Cod Water Protection Collaborative was created by county ordinance in 2005 and exists to offer a coordinated approach to enhance the water and wastewater management efforts of towns, the regional government and the broader community. The Collaborative seeks to protect Cape Cod's shared water resources and to provide access to cost effective and environmentally sound wastewater infrastructure. The Collaborative seeks funding support for Cape communities, establishes priorities, directs strategy, builds support for action, and fosters regionalism.

TOWNS

All 15 Cape Cod towns have engaged to some degree in the process of developing CWMPs over the last 10 years. Several towns are in the MEPA review process. A Cape Cod Commission regulatory review file of comment letters, public hearings and decision documents are available for each town that is undergoing the MEPA/DRI review process for their CWMP. Towns with existing wastewater infrastructure including Barnstable, Chatham, Falmouth and Provincetown, completed wastewater facilities plans prior to or in conjunction with nutrient planning.

Why Hasn't There Been More Progress?

Despite the efforts described above, few communities have implemented nitrogen remediation programs that will meet water quality standards.

COST

Cost has been the major impediment to wastewater plans on Cape Cod. The existing wastewater costs to homeowners are hidden. Most people don't recognize the annualized expense of owning and maintaining a Title 5 system.

More than 30% of the housing stock in the region is seasonal. In some towns that figure is as much as 60%. This creates a peak-flow pricing issue for most towns because facilities are sized for a peak flow which occurs only four weeks a year - the last two weeks of July and the first two weeks of August. Less than 4% of the state's population lives on Cape Cod yet the region is home to 20% of the Title 5 systems.

Towns need to stimulate their tax base in order to afford the wastewater costs necessary to meet water quality standards and, at the same time, the economic development necessary to achieve that result is limited by the problem that needs to be solved. Without additional ability to treat wastewater, towns don't have the capacity for appropriate nitrogen-reducing patterns of growth.

LACK OF LOCAL CONSENSUS

Progress on water quality issues related to wastewater is always challenging. The solutions are generally expensive and it is easy for people not to think about what happens after they flush. Education efforts on Cape Cod have been

successful in identifying wastewater as a problem but more work is necessary for a majority of people to recognize that septic systems contribute most to the problem.

Local planning and zoning were ineffective in preventing sprawled residential development patterns that increase the cost of conventional wastewater solutions.

The politics of wastewater is difficult. On the Cape, towns are the primary fiscal agents involved in building wastewater systems. Appropriations on a municipal level that authorize borrowing require a two-thirds vote of the local legislative body. In the Town of Barnstable that is the Town Council. In the other 14 towns the legislative body is town meeting.

LACK OF ENFORCEMENT

Federal and state enforcement tools are imperfect and rely on permitting dischargers. Current enforcement actions would lead to expensive compliance requirements without necessarily resulting in achieving water quality goals.

The web of federal and state regulations governing wastewater management were created to address the water quality challenges of 40 years ago. While the important goals of those efforts remain applicable, the regulatory scheme driving planning and design efforts to meet those goals is inflexible and poorly suited to solving the problems facing the Cape. The current regulations favor centralized treatment approaches and have no effective means for incorporating alternative approaches into a conventional permit.

REGULATIONS LIMIT OPTIONS AND INNOVATION

The regulatory framework in place was built to solve other problems. Existing regulatory drivers overbuild expensive solutions dependent on point-source technologies to solve a nonpoint source problem. This doesn't account for the unique challenges of Cape Cod as a coastal community with a marine water quality issue caused by nutrients and a relatively low-density development pattern.

This plan highlights the need for modifications to the regulatory approach to reflect the predominance of septic system effluent as the primary problem to be solved and to expand the use of alternative and non-traditional technologies and management strategies necessary to meet the unique circumstances of Cape Cod. State development of a watershed permitting process is the essential step in reforming the regulatory environment to unlock the financial savings and management potential of watershed based solutions that rely on a mix of technologies and approaches. Other regulatory reforms are recommended to create the right incentives for the implementation of 21st century solutions to a problem that has been long developing.

The Cape Cod Model

This update provides a regional analysis of watersheds and the nitrogen problem. The review of local nutrient management planning, consideration of the best available scientific assessments and the collection of all relevant geographic data resulted in a recommended new approach to solving the nitrogen problem with specific strategies for better designed and effective watershed-based solution at lower cost with more community support.

COMMUNITY ENGAGEMENT

The Cape Cod Commission committed to an extensive public engagement process to bring more voices to the table in order to develop consensus around a range of solutions to solve water quality problems. The public participation and engagement process was Cape-wide and included both subregional and watershed specific working groups.

There were a number of challenges associated with the complexity of the task and the short time frame for completion. The challenges included:

- Ensuring a high level of process objectivity,
- Staying on task and on time,
- Coming to agreement on potential solutions,
- Addressing the issue of affordability,

- Creating opportunities for regulatory flexibility, and
- Educating and engaging the broader Cape Cod community.

The process took advantage of existing teams and created new teams to tackle each challenge efficiently and effectively.

EXISTING TEAMS

Existing Cape-wide organizations already working on wastewater and nutrient management issues were enlisted to avoid redundant effort and transfer existing knowledge, expertise and data sets.

Cape Cod Water Protection Collaborative Governing Board and Technical Advisory Committee

The Governing Board of the Collaborative reinstated monthly meetings in May 2013 to follow the Section 208 Plan Update process. The Governing Board has 17-members and approves all expenditures, policies and strategies of the Collaborative. Membership consists of an appointed member from each town in addition to two County Commissioners' appointees.

In addition, the Technical Advisory Committee (TAC) of the Cape Cod Water Protection Collaborative was reformed and re-chartered to look at some of the technical aspects of the Section 208 Plan Update. Specifically, the TAC reviewed and commented on the Water Quality Technologies Matrix and helped to develop and refine a series of one-page fact sheets for watershed stakeholders and community use. The TAC consists of one appointed representative from each town and a MassDEP representative to provide the regulatory, permitting and technical perspectives.

NEW TEAMS

New teams were created, as necessary, to provide overall guidance on the plan's progress and separate subject matter advice. Each team established a timeframe for performance and an agreed upon statement of purpose.

Regulatory, Legal and Institutional Work Group

A Regulatory, Legal, and Institutional (RLI) Work Group, with representation from MassDEP, US EPA, the Cape Cod Commission, and other State and Federal partners, as necessary, addressed the potential need for regulatory reform and other challenges associated with planning and implementation. Increased coordination between local, state and federal regulatory requirements was identified by the Commission as a need moving forward and the group met monthly to discuss this and other opportunities and challenges related to the Section 208 Plan Update.

Advisory Board

A six-person advisory board, which meets monthly, was convened with representation from the four subregional planning areas, along with two ad hoc members. Members have current or prior experience in municipal government and/or experience with other regional-scale issues, such as the groundwater cleanup at Joint Base Cape Cod and regionalizing school districts. The mission of the board is to support the Section 208 Plan Update planning process by providing advice on the overall approach, reviewing draft work product and offering insight on strategic and tactical decision-making.

Finance Committee

A Finance Committee, which meets monthly, was convened with representation from local communities and support from consultants to the Cape Cod Commission for the Section 208 Plan Update. Members include a town administrator, a finance director and a municipal finance committee member. The mission of the committee is to work with the consultants to the Commission to establish a factual basis for discussing issues of affordability, financing and resources related to the Section 208 Plan Update.

Technologies Panel

A Technologies Panel, which met four times over the course of two months, was convened to review, confirm, and

expand upon the matrix of technology options developed through and used in the Section 208 Plan Update process, review the overall planning approach in each watershed, and provide input on a site screening methodology for green infrastructure technologies. The panel consisted of local, national, and international experts on the impact of nutrients in coastal waters, remediation approaches, and emerging technologies.

Monitoring Committee

A Monitoring Committee, which meets monthly, was convened in April 2014. The mission of the committee is to provide advice and guidance on appropriate monitoring protocols for technology efficiency and total maximum daily loads, while identifying a process for consolidating all available monitoring data in a central location and format. Members include representatives from MassDEP, US EPA, academic institutions, non-profit organizations, and other government agencies. Among the roles and responsibilities of this committee are to:

- Establish performance monitoring protocols for technologies that may be a part of watershed permits in the future;
- Establish compliance monitoring protocols for meeting TMDLs in the water body;
- Establish process and structure for consolidating and cooperation of existing monitoring programs and data in to a centralized location; and
- Identify region-wide monitoring needs and develop proposals.

WEB-BASED CAPE-WIDE ENGAGEMENT

In an effort to reach groups not normally associated with wastewater or planning projects in general we employed a web-based Cape-wide engagement project. In conjunction with Emerson College's Engagement Game Lab, the Commission tailored the Community PlanIt platform to create and run CAPE2O, an on-line game-based engagement tool. Two different three-week games saw more than 900 people register and generated more than 6,000 comments and questions on water quality issues. CAPE2O introduced players to the nutrient problems on Cape Cod through different problem-solving perspectives including science, civics, economics and consensus building.

STAKEHOLDER ENGAGEMENT

Subregional Public Meetings

To start the stakeholder process, two meetings were held in each of the four subregions – one in July 2013 to introduce the process and develop the watershed working groups and one in August 2013 to introduce information around affordability of infrastructure and discuss what people on Cape Cod are currently paying for water and wastewater infrastructure. These meetings helped to engage the communities and establish the watershed working groups discussed above. The purpose of the subregional meetings was also to recruit stakeholders.

Watershed Working Groups

Working groups, made up of 15-20 self-selected stakeholders (about 170 people Cape-wide), were associated with each watershed group and subregional group. Each working group consisted of the following general representation: Local Elected Officials, Wastewater Committee Members, Town Professional Staff, Local Business Owners/Operators, Local Environmental Organizations, Civic Group Members, Alternative Technology Interests, Development/Real Estate Community and Interested/Concerned Citizens.

In Fall 2013, each working group met three times in four-hour-long professionally facilitated meetings – once in September to discuss the baseline information in each of their watersheds, including land use, nitrogen related water quality impairments, pond water quality, and existing and proposed infrastructure, once in October to discuss the

range of technologies and approaches that might be used on Cape Cod, and once in December to discuss the process for applying technologies and approaches in each watershed.

Subregional Working Groups

Following the three sets of watershed working group meetings the conversation shifted from discussing the jurisdiction of the problem, at the watershed level, to the jurisdiction of the solution, at the subregional level. In early 2014, watershed working groups were asked to self-select into subregional groups, with representation from each of the watershed working groups and in each of the categories established as part of the watershed working group process.

The structure of the subregional meetings was different from the watershed working group meetings, which had discrete topics associated with each meeting. The subregional meetings were iterative, with a standing agenda that included scenario planning; regulatory, legal, and institutional issues; and implementation. Each subregion met three times in four-hour-long meetings. Meetings included representation from MassDEP and US EPA and were also professionally facilitated.

CAPE-WIDE MEETINGS

On November 13, 2013, the Commission held a Watershed Event to conclude the Cape2O game, award prizes to participants and provide funding to top projects associated with the game. About 120 people attended, including stakeholders and Cape2O players, regulatory agency staff, and members of the public. Speakers included Cape and Islands Senator Dan Wolf, as well as representatives from the US EPA and MassDEP. In addition to discussing the outcomes of the Cape2O game the time was used to begin the discussion around structuring the second half of the stakeholder engagement process – the subregional working group meetings.

On February 6, 2014, the Commission held a day-long Stakeholder Summit to review the work to date and discuss the path toward development of the Section 208 Plan Update. About 270 stakeholders, regulatory agency staff, and members of the public attended the event. Speakers included the State Treasurer, MassDEP Commissioner, CEO of the Cape Cod Chamber of Commerce, representatives from the US EPA and the Cape Cod Commission. The discussion focused on the importance of community involvement in the Section 208 Plan Update planning process and the need to meet water quality goals in Cape Cod's estuaries. Breakout sessions included preliminary conversations on scenario planning, regulatory, legal, and institutional issues, and implementation issues, in order to set the stage for the upcoming Subregional Working Group sessions.

TECHNICAL REVIEW

A WATERSHED APPROACH

A watershed approach looks at the jurisdiction of the problem – all of the contributing sources within a watershed (or the receiving water itself), without regard to political boundaries. A watershed is a geographic area separated from other regions by drainage divides, within which all water flows to a common outlet, such as an embayment. Watersheds do not follow the municipal boundaries separating one town from another. Of the 53 watersheds to coastal embayments addressed in this document, 32 are shared by more than one town. Although wastewater planning has been underway on Cape Cod for more than a decade, the current process has been uncoordinated and in many areas represents only a partial solution to the problem resulting in approval of municipal CWMP's that will not meet water quality standards in shared water bodies.

SOLUTIONS CLASSIFIED AND EVALUATED

This report examines 10 categories and a total of 67 nutrient reduction, remediation, and restoration technologies and approaches. Both conventional and alternative means are represented in those groupings. This

work is embodied in the Water Quality Technologies Matrix and then simplified based on the point of intervention and the scale of the technology or approach.

At what point in the nitrogen cycle the intervention takes place determines if the effort is reducing the nitrogen load at the source or reducing the impact of nitrogen already loaded into the ground water or the affected water body. This report classifies technologies and approaches as Reduction, Remediation, and Restoration interventions.

Technologies and approaches considered can be more or less effective and efficient depending on the scale of use. This report groups them based on Site, Neighborhood, Watershed or Cape-wide applicability. It is important to note that not every technology and approach is appropriate for every watershed. Evaluation of these options with the tools developed as part of the Section 208 Plan Update and detailed below is necessary as a preliminary step placing selected options in a watershed-specific scenario.

INFORMATION AND DECISION SUPPORT TOOLS

The process of collecting and analyzing such a large and comprehensive amount of information and a need to organize and analyze many geospatial data layers simultaneously produced a number of important new information products. These new decision support tools and the supporting databases and methodologies will be available through the Cape Cod Commission's Watershed Team technical assistance program. These tools make complex data sets more easily understood and provide an avenue for increased and informed deliberation at the local and hyper-local planning levels. This will expedite the selection and implementation of watershed solutions.

TWO PERSPECTIVES ON ONE PROBLEM

Implementation of wastewater solutions have failed to garner the 2/3rds Town Meeting votes necessary to appropriate money to build in most communities. Many of the plans have suffered a "death by a thousand cuts." The arguments against tend to fall into three categories: Science, Solutions (proposed strategies and technologies) and Cost.

As noted above, a group of experts was empaneled to review the scientific underpinning of the Massachusetts Estuary Project and approved its use by communities in making directionally correct decisions regarding solutions.

This document outlines a technical review process designed to provide insight into the remaining two categories, Solutions and Cost. The concerns often resulted in polarizing local debates, sometimes discussed in terms of centralized versus de-centralized approaches or traditional solutions versus alternative solutions. One of the key distinctions depends on a considered option's reliance on a permanent physical connection among multiple sources, a collection system. The process outlined in this report grouped points of view associated with these categorizations into two approaches to solving Cape Cod's nitrogen problem: a traditional approach and a non-traditional approach.

Two teams worked independently in the application of agreed upon conditions outlined as follows:

- Both approaches consider the entire controllable load.
- Both start with identified nitrogen reduction targets.
- Both agree that nutrient reduction goals can be adjusted based on a watershed's adoption of certain policies that will reduce or eliminate nutrient loading from certain sources, fertilizer reduction and stormwater management.
- Both approaches illustrate an attempt to solve the problem within the boundaries of the watershed as an environmentally preferable result, when possible.
- As a mutual point of reference, the traditional team evaluated a hypothetical analysis of an "all sewer" scenario and compared it to an "all innovative/alternative septic system" scenario. Neither was a best choice for taxpayers or the environment. This evaluation suggested scenario approaches be targeted and mixed, where appropriate.

Traditional Approach Process

The traditional (collection system) approach considered the greatest controllable source of pollution as a percentage of the whole, aggregated nitrogen in the most efficient grouping of sources, and suggested collection and treatment options.

Starting with the agreed upon nitrogen removal target, the review team applied low barrier technologies and approaches, applying nitrogen reduction credits to the watershed for fertilizer reductions and stormwater management. They targeted and identified nitrogen loads and an appropriate collection system to treat and dispose effluent within the watershed. Next the team adjusted the size of the necessary collection by considering treatment and disposal outside of the watershed. The process illustrates the cost and effectiveness of traditional strategies, potential economies of scale with shared treatment and disposal, and potential limitations to the environmentally preferred option of a watershed-based solution. The traditional approach provides an instructive backdrop for an adaptive management approach to managing nitrogen in watersheds.

Non-Traditional Approach Process

The non-traditional approach started with the premise that collection systems should be avoided or minimized to the greatest extent possible. Although conventional wisdom and practice suggests that economies of scale in the construction of wastewater treatment facilities result in the least expensive and most effective treatment, there is valid concern that the case studies supporting this view are from more urban communities with existing but degraded infrastructure. Cape Cod is missing both of these qualifications, having neither the density characteristics nor the existing infrastructure. The Cape also has an attribute not shared by other communities - its seasonal second home owner economy, which creates a peak-flow problem when building wastewater treatment facilities and creates a situation where facilities are overbuilt for 48 of 52 weeks a year.

Additionally, there are people in every community advocating for wastewater solutions that rely less on structural interventions and favor those that enhance natural systems. The technologies and strategies prioritized in the non-traditional approach also tend to result in less movement of water between watersheds and put a greater emphasis on comprehensive system restoration or improvement.

The non-traditional approach team began with the same nitrogen removal target as the traditional team and applied low barrier technologies and approaches, assigning nitrogen reduction credits to the watershed for fertilizer reductions and stormwater management. It then considered an array of watershed/embayment options, as detailed in the Water Quality Technologies Matrix, consisting of a broad range of innovative and non-traditional nitrogen management strategies to either intercept and treat nitrogen in the groundwater or to assimilate and treat them in the receiving waters.

Watershed practices include permeable reactive barriers (PRBs), constructed wetlands, phytoremediation, and fertigation wells, among others. Embayment treatment practices include, but are not limited to, shellfish bed restoration, aquaculture, floating wetlands, dredging and inlet modifications.

The next step considered alternative on-site options that have been screened for geographic suitability. A number of alternative wastewater source controls were evaluated in this step. These include ecotoilets and I/A septic systems. Ecotoilets are alternative toilets that target the source within the building. These include urine diversion (UD), composting, incinerating, and packaging toilets where the waste materials are collected and temporarily stored before processing. These technologies allow little or no human waste to enter the septic system (only gray water from the shower, laundry and sinks).

Social acceptability issues had the team using these strategies in a targeted way, schools for example.

Plan Summary

Among the actions needed to validate the efficacy of non-traditional approachesare piloting, monitoring and analyzing technology performance.

The non-traditional approach produced a targeted starting point for consideration as part of an adaptive management program in most watersheds.

MONITORING

In order for a broader range of technologies and options to be considered a long-term monitoring program must be established to provide technology specific monitoring protocols as well as an enhanced water quality monitoring program in the degraded water bodies.

ADAPTIVE MANAGEMENT

This recommended approach creates a predictable framework for adaptive management. It will allow communities to move forward in a targeted manner to begin to address marine water quality issues now. The traditional and non-traditional approaches can serve as the outer bounds of an adaptive management plan.

ADAPTIVE PLANNING

Although two independent watershed evaluation strategies were used the results have produced a recommended hybrid watershed planning approach. Included in this approach is the consideration of additional non-nitrogen collection needs in the watershed and expanded options for nitrogen reduction, remediation and restoration efforts producing watershed scenarios vetted by a community engagement process producing an adaptive management plan to be incorporated in a watershed permit.

Conclusion

The qualitative water quality goals of the Clean Water Act are not being met on Cape Cod. We are moving in the wrong direction. There has been no debate about the goal of clean water, but the regulatory drivers are producing point source solutions for non-point source problems. Regulatory enforcement actions based on quantitative measures are clear for point source discharges but not for non-point sources. The resulting dissonance has led to litigation attempting to define nutrient pollution related to wastewater as a point source to access more established enforcement action. The discussion has to move beyond this legal impasse. This update focuses on promoting more efficient and effective non-point source strategies designed to meet the qualitative goals of the Clean Water Act.

An update to the Clean Water Act that promotes and supports a non-point source nutrient control program and provides a clear path to compliance for communities will allow the goals of the Act to be more effectively and efficiently realized. The Commonwealth of Massachusetts has an opportunity to allow an innovative and common sense approach to solving the problem.The biggest controllable source of nitrogen on Cape Cod is subject to existing state authority. This update provides a path toward clean water based on the best information available that will make it easier for the 15 towns on Cape Cod to implement effective solutions without excessive costs.

This Section 208 Plan Update recommends actions to streamline the regulatory process, make complex information more transparent and available to citizens, abate nitrogen-induced costs already impacting the region, provide more support to local community water quality efforts, and eliminate unnecessary costs.

Introduction

As the population of Cape Cod increased over the last several decades, so has the volume of nutrients entering its coastal waters and freshwater ponds. The population of Cape Cod has increased by about 60% since the completion of the 1978 Water Quality Management (WQM) Plan, developed under Section 208 of the Federal Clean Water Act by the Cape Cod Planning and Economic Development Commission (CCPEDC), the predecessor to the Cape Cod Commission (Commission). Development associated with this growth is largely in the form of residences. Wastewater from both older and newer housing stock is predominantly treated by on-site septic systems that do not adequately remove nitrogen. Nitrogen from these systems is released to groundwater which ultimately discharges to the surrounding coastal waters. Excessive nutrients, such as nitrogen and phosphorus, are the documented cause of eutrophication in a majority of Cape Cod estuaries and freshwater ponds. In estuarine systems, nitrogen leads directly to thick mats of algae that replace eelgrass, diminish shellfisheries, and decrease dissolved-oxygen concentrations—occasionally leading to fish and shellfish kills, odor and frequent violations of water quality standards.

Cape Cod has less than 4% of the population of the Commonwealth but 20% of the septic systems. Only 3% of the parcels and 15% of the wastewater that flows on Cape Cod are centrally treated. Wastewater accounts for about 80% of the controllable nitrogen load entering Cape Cod's coastal waters.

This report documents an update to the 1978 Section 208 Plan for Cape Cod. In a January 30, 2013 letter (See Appendix A), the Massachusetts Department of Environmental Protection (MassDEP) directed the Cape Cod Commission to prepare an update to the 1978 WQM Plan for Cape Cod to address the degradation of Cape Cod's water resources from excessive nutrients, primarily nitrogen.

Accompanying the directive was a commitment to provide the Cape Cod Commission with $3,350,000 from the Massachusetts Water Pollution Abatement Trust to fund the update. The Memorandum of Understanding, dated March 21, 2013 (See Appendix B) between the Massachusetts Water Pollution Abatement Trust (Trust), MassDEP and Barnstable County, acting by and through the Commission, stipulates roles, responsibilities, terms and conditions under which the Section 208 Plan Update was completed.

After review and acceptance of a detailed budget and work plan, the Trust and MassDEP provided a notice to proceed on the full Section 208 Plan Update on May 7, 2013 (See Appendix C).

The Cape Cod Commission was given 12 months to submit a draft Section 208 Plan Update to MassDEP and the United States Environmental Protection Agency (US EPA), which was fulfilled in June 2014. A 60-day review period was provided to the agencies and a public draft was released in August 2014 for an extensive 90-day public comment period. All of the comments received, along with responses prepared by the Commission, can be found in Appendix D.

Authority

The Cape Cod Commission is, pursuant to the Cape Cod Commission Act (See Appendix E), the regional planning agency for Barnstable County. The Commission is charged with furthering "the conservation and preservation of natural undeveloped areas, wildlife, flora and habitats for endangered species; the preservation of coastal resources including aquaculture; the protection of groundwater, surface water and ocean water quality, as well as the other natural resources of Cape Cod; balanced economic growth; the provision of adequate capital facilities, including transportation, water supply, and solid, sanitary and hazardous waste disposal facilities; the coordination of the provision of adequate capital facilities with the achievement of other goals; the development of an adequate supply of fair affordable housing; and the preservation of historical, cultural, archaeological, architectural, and recreational values."

The purposes and provisions of the Cape Cod Commission Act require that the Commission "anticipate, guide and coordinate the rate and location of development with the capital facilities necessary to support such development;" therefore, the Commission has the power "to establish a process and procedures for siting and developing capital facilities and developments of regional impact which are necessary to ensure balanced growth."

The Cape Cod Commission was created by an act of the Massachusetts Legislature and ratified by the voters of Barnstable County in 1990 in response to the rapid development pressure of the 1980s. The increased pace of development focused attention on the need to manage growth, guide land use, promote balanced economic growth, provide for adequate capital facilities and infrastructure, and protect environmental resources. The Commission has planning, technical and regulatory tools that can be applied to water quality management on Cape Cod. The Commission has independent statutory authority and is a department within the structure of Barnstable County government. The Cape Cod Commission is also the State-designated area wide water quality management planning agency for Barnstable County.

In 1985 the United States Environmental Protection Agency promulgated regulations (40 C.F.R. §130.6) to provide for WQM planning programs, which

"consist of initial plans produced in accordance with §208 and §303(e) of the [Clean Water] Act and certified and approved updates to those plans." As stated in 40 C.F.R. §130.6(e), a State is authorized to update these WQM plans "as needed to reflect changing water quality conditions, results of implementation actions, new requirements or to remove conditions in prior conditional or partial plan approvals."

As described above, the Commonwealth exerted its authority under Section 208 of the Clean Water Act and 40 C.F.R. §130.6 to designate an agency and require an update to address the critical need for nutrient remediation in Cape Cod water bodies by designating the Commission as the responsible agency and directing the Commission to update the 1978 Section 208 Plan in 2013.

The 1978 Section 208 Plan

The 1978 Section 208 WQM Plan (1978 Plan) for Cape Cod described the major water quality and wastewater management problems confronting the region and recommended land use controls, wastewater management, nonpoint source controls and institutional arrangements to improve water quality.

Specifically, the plan identified increasing residential densities and a three-fold summer population influx as the cause of isolated water quality and wastewater management problems. It anticipated that future growth, primarily in more inland areas where most public water supply wells are located and along the shores of the Cape's many inland ponds, threatened to cause more serious groundwater contamination and increased eutrophication of surface waters.

The emphasis of the 1978 Plan recommendations was on providing for the protection of drinking water quality and quantity. The plan recommended that towns establish protective overlay districts for major "Water Resource Protection Areas," within which residential density would be limited and major polluting uses would be prohibited in order to protect groundwater, surface waters, and coastal waters. It was suggested that the most highly protected areas be those that contribute recharge to public drinking water supply wells. Additionally, it was recommended that towns cooperate in regional water supply planning to encourage water supply self-sufficiency and to develop and implement appropriate protection measures.

The 1978 Plan generally concluded that septic systems that comply with Title 5 of the Massachusetts Environmental Code (310 C.M.R 15.00) were an adequate form of wastewater disposal for the Cape's development. At the time, about 90% of the Cape's year round population relied on on-site septic systems and the plan recommended that the majority of the population could continue to rely on this form of disposal over the 20-year planning period. However, the plan did identify isolated sewer service areas and suggested that the towns of Barnstable, Bourne, Chatham, Falmouth, Provincetown,

and Sandwich proceed with Clean Water Act §201 facilities planning and construction to remediate water quality or other Title 5 related issues within their communities.

To accommodate the majority of development that would remain connected to on-site disposal systems, the 1978 Plan recommended that all towns participate in an effort to regionalize septage treatment and disposal, as well as develop on-site system management programs to ensure proper maintenance and strict enforcement of Title 5, including the upgrading of failing systems and proper installation practices supervised by qualified local health agents (CCPEDC 1978).

Environmental Conditions Requiring an Update

Nitrogen enters marine ecosystems from many different sources. For the purpose of this report they are classified as uncontrollable sources, such as the atmospheric deposition of nitrogen, and controllable sources, such as wastewater, fertilizer and stormwater. This update focuses on nitrogen loads from controllable sources. The uncontrollable loads are accounted for in the calculation of the nitrogen capacity for a given waterbody.

Cumulative concentrations of nitrogen in groundwater, which are substantially lower than drinking water standards, have a significant impact on coastal resources. These impacts are due to the incomplete removal of nitrogen from on-site Title 5 septic systems that were found to be adequate for drinking water protection in the 1978 Section 208 Plan.

Since the 1978 Plan was developed, Cape Cod communities have worked closely with Barnstable County, the Commonwealth, and the Massachusetts Estuaries Project (MEP) to identify the causes and degree of impairment in coastal water bodies. Cape Cod knows more now about the sources of coastal water quality degradation, and potential solutions, than was understood in 1978.

Cape Cod's water resources drive the regional economy. They attract visitors in the summer months and make the Cape a desirable place to live for year-round and seasonal residents. Continuing and increasing nitrogen loading of Cape Cod's embayment watersheds will further degrade coastal water quality, adversely impacting environmental, economic, and societal norms. The economic impact of doing nothing to restore coastal water quality will be significant, affecting every home owner in the region.

Cape Cod has recently been the subject of a lawsuit on this issue. The original lawsuit, filed by the Conservation Law Foundation (CLF) against US EPA, asserts that US EPA violated the Clean Water Act and its regulations by failing to regulate nonpoint sources of nitrogen which have degraded the embayments in a manner that has injured the recreational, commercial and aesthetic interests in those waters. This lawsuit was dismissed for lack of standing.

In a refiled suit, CLF has asserted that the US EPA's mandatory annual review of how Massachusetts administers its State Revolving Fund (SRF) has been contrary to law. Specifically, under the Clean Water Act, the US EPA has the authority to grant money to a state's SRF fund for certain types of wastewater management projects subject to certain restrictions on the use of the funds. The US EPA has a duty to review a state's plans and reports concerning the state's use of those funds on an annual basis.

CLF sought an injunction requiring that (1) the US EPA notify the Commonwealth of its noncompliance; and (2) an update to the Section 208 Area Wide Water Quality Management Plan be completed within one year. The US EPA sought and received a stay of this lawsuit until June 1, 2015, pending review and approval of this updated Section 208 Plan.

In November 2014, CLF and US EPA filed a settlement agreement in US District Court requesting an extension of the existing stay of the Section 208 Action from June 1, 2015 to September 15, 2015, a stay of the TMDL Action until September 15, 2015, and a dismissal of both actions upon completion of a series of actions to be completed by US EPA, including the approval of the Cape Cod Section 208 Plan Update.

The time for Cape Cod communities to act is now. Approval of the Cape Cod Section 208 Plan Update by US EPA and implementation of the principles and recommendations set forth will ensure local control over selection and application of technologies and management of water resources into the future.

A New Approach

THE SECTION 208 PLAN UPDATE – PURPOSE, GOALS, AND PROCESS

PURPOSE

The purpose of the Section 208 Plan Update was to develop an integrated water and wastewater management system that includes a series of phased approaches to remediate groundwater and surface water impairments in each watershed.

GOALS

The goals of the Section 208 Plan Update include:

- To provide an unbiased evaluation of technologies and approaches that may be appropriate in each watershed;
- To promote the use of sustainability criteria in decision making;
- To work with State and Federal partners on regulatory changes necessary to implement adaptive management plans, including the permitting of alternative approaches and appropriate enforcement mechanisms;

- To develop cost effective management strategies for implementing pilot projects, targeted watershed plans, and watershed plans for shared infrastructure; and
- To identify ways to measure and control unanticipated growth made possible through the development of wastewater infrastructure.

PROCESS

The process used in this update is watershed-based, includes a focus on both stakeholder engagement and technical evaluation, seeks to maximize the benefits of local planning, considers the full range of traditional and non-traditional strategies, and favors allowing local stakeholders to decide which of a range of options to pursue, instead of mandating a single "optimal" solution. Affordability and ancillary benefits to Cape Cod's economy and society are considered in the proposed range of approaches.

Overcoming these significant challenges to restoring many of Cape Cod's marine ecosystems requires a new approach. The Section 208 Plan Update reflects a new approach with five basic principles.

1. The plan is watershed based. The most effective and efficient solutions are found by beginning with the consideration of solutions within the jurisdiction of the problem.
2. The plan leverages existing local plans by making use of the enormous amount of data and input already collected by Towns as part of their comprehensive wastewater management planning to date.
3. All solutions are considered – everything has to be on the table. The plan takes into account all technologies and strategies that may be successful on Cape Cod. It evaluates each individually and then looks for appropriate places for its use as part of a watershed scenario.
4. The purpose of the plan is to set the parameters for the discussion of solutions on a watershed basis, and **not** to suggest an optimal solution.
5. Cost must be considered as part of every watershed scenario and the impact on individual homeowners must be a primary concern. If a solution isn't affordable, it isn't doable.

The plan outlines a path forward with recommendations for implementation. The recommendations can be organized into four categories: information, regulatory reform, support, and cost. The Plan identifies areas where more information is needed, where more support can be offered, where regulatory reforms are necessary and suggests options for additional financial support.

01 PEOPLE

The Cape Cod Model - People & Process

Section 208 of the Federal Clean Water Act emphasizes public engagement as much as the technical aspects of the regional planning process. The Cape Cod Commission committed to extensive public engagement to bring more voices to the table in order to develop consensus around a range of solutions to solve water quality problems. The public participation and engagement process was Cape-wide and included both subregional and watershed specific working groups. It took advantage of existing teams, such as the Cape Cod Water Protection Collaborative, and created new teams, as necessary, to address the challenges associated with this extensive and time-constrained planning process.

STAKEHOLDER PROCESS

strategies for establishing consensus in a regional planning process

Section 208 of the Federal Clean Water Act emphasizes public engagement as an important part of the regional planning process. The Cape Cod Commission committed to an extensive public engagement process to bring more voices to the table in order to develop consensus around a range of solutions to solve water quality problems.

OBJECTIVE

In order to be successful, the planning process needed to remain objective. The Commission brought in the Consensus Building Institute to provide facilitation in order to build collaboration and agreement among stakeholders.

ON SCHEDULE

To ensure the Section 208 Plan Update stayed on task and was delivered on time the Commission engaged the Cape Cod Water Protection Collaborative Governing Board and created a new Advisory Board. These Boards provided advice on the overall approach, reviewing draft work product and offering insight on decision-making.

AGREEMENT

The Commission built consensus by working across town lines and identifying solutions at the watershed level. A range of stakeholders was convened at the watershed and the subregional level to consider watershed-based solutions and strategies.

AFFORDABLE

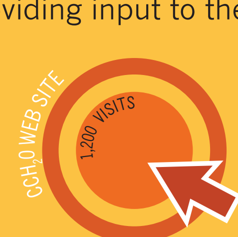
A basic principle of the Section 208 Plan Update is that cost be considered as part of every watershed solution and the financial impact on individual homeowners be a primary concern.

FLEXIBLE

To ensure regulatory flexibility in planning and permitting was addressed, the Regulatory, Legal and Institutional Work Group advised on regulatory reform and increased coordination between local, state and federal regulatory requirements. The Monitoring Committee provided advice on monitoring protocols and a process for monitoring data to inform adaptive management.

ENGAGING

The Plan involved the broadest possible Cape community through a variety of public engagement initiatives. Cape-wide meetings and web based tools provided educational information and a non-traditional way of providing input to the process.



Process Challenges and Solutions

The Cape Cod Commission (Commission) was given 12 months following the receipt of funds associated with the Section 208 Plan Update to provide a draft document to the Massachusetts Department of Environmental Protection (MassDEP) and the United States Environmental Protection Agency (US EPA). The draft document needed input from individuals Cape-wide in order to address regional concerns and develop consensus around solutions. The challenges associated with the complexity of the task and the short time frame required efficient and effective strategies. The Section 208 Plan Update utilized existing organizations and created new boards and committees (see **Figure 1-1** on following page) to work toward developing solutions to these challenges.

CHALLENGE: HOW TO ENSURE PROCESS OBJECTIVITY

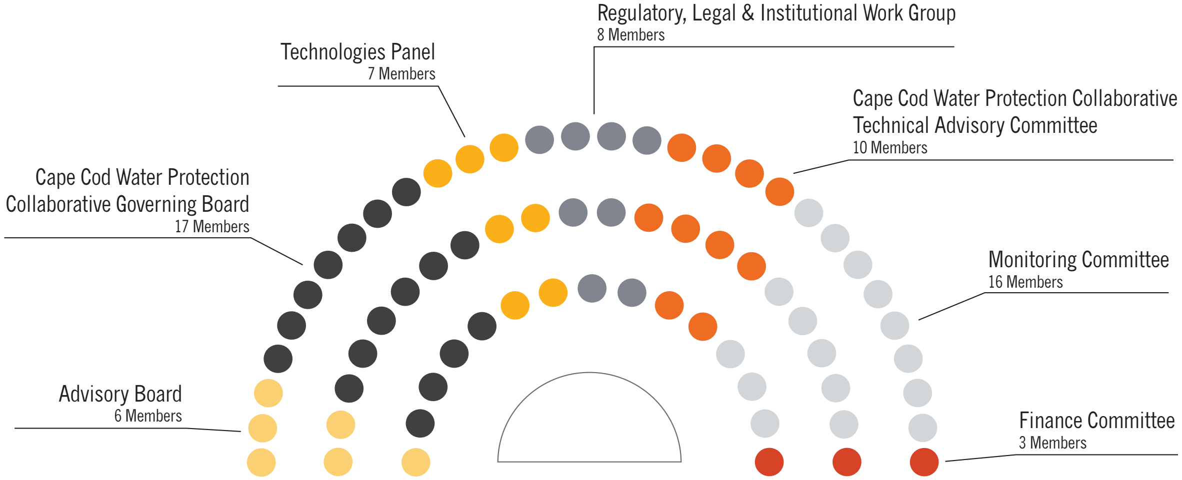
A plan that would address the needs of the region and represent the communities' specific watershed goals and solutions required input from a range of stakeholders with a range of opinions and ideas. In order to be successful, the planning process needed to remain objective.

The Consensus Building Institute (CBI) of Cambridge, MA is an experienced not-for-profit organization focused on negotiation and dispute resolution. As third-party facilitators they work to build collaboration and agreement in complex environments.

The Commission brought CBI on to the project to provide guidance on developing a process for engaging communities in a discussion around watershed impairments and appropriate solutions. Its staff provided third-party facilitation at the watershed, subregional and Cape-wide levels to ensure that all stakeholders were given opportunities to participate and that the Commission effectively responded to concerns and incorporated feedback throughout the process. CBI held all parties involved to a high standard of communication and cooperation in addressing this difficult issue.

Challenges Requiring Solutions

- ☑ Ensuring Objectivity
- ☑ Staying on Task and on Time
- ☑ Reaching Agreement
- ☑ Addressing Affordability
- ☑ Creating Pathway for Regulatory Flexibility
- ☑ Engaging the Broader Public



Section 208 Plan Update Committee Membership

Figure 1-1

CHALLENGE: HOW TO STAY ON TASK AND ON TIME

To ensure the Section 208 Plan Update stayed on task and was delivered on time the Commission engaged an existing team, the Cape Cod Water Protection Collaborative (Collaborative) Governing Board, and a new team, the Section 208 Plan Update Advisory Board.

COLLABORATIVE GOVERNING BOARD

The Collaborative was created by county ordinance in 2005 and exists to offer a coordinated approach to enhance the water and wastewater management efforts of towns, the regional government and the broader community. The Collaborative seeks to protect Cape Cod's shared water resources and provide access to cost-effective and environmentally-sound wastewater infrastructure. The Collaborative seeks funding support for Cape communities, establishes priorities, directs strategy, builds support for action and fosters regionalism.

The Collaborative Governing Board reinstated monthly meetings in May 2013 to follow the Section 208 Plan Update process from start to finish. The Governing Board's 17-members approve all expenditures, policies and strategies of the Collaborative. Membership consists of an appointed member from each town (typically a Selectmen or staff member) in addition to two County Commissioners' appointees. Monthly updates were provided to the Board, which was given a chance to comment and provide feedback. See Appendix 1A for a list of members and their affiliations, as well as meeting information.

208 PLAN UPDATE ADVISORY BOARD

A six-person Advisory Board met monthly and was convened with subregional representation and ad hoc members with regional points of view and experience. Members had current or prior experience in municipal government and/or experience with other regional-scale issues, such as groundwater cleanup at Joint Base Cape Cod and regionalizing school districts.

The mission of the board was to support the Section 208 planning process by providing advice on the overall approach, reviewing draft work product and offering insight on strategic and tactical decision-making. See Appendix 1B for a list of members and their affiliations, as well as meeting information.

CHALLENGE: HOW TO COME TO AGREEMENT ON SOLUTIONS

At the outset, the Commission sought to build community consensus across town lines and identify solutions within the jurisdiction of the problem - watersheds. The most effective and efficient solutions are found by beginning consideration of solutions at this level.

To begin this effort, a chronology of municipal planning efforts was developed for each town. It established what had been done, identified successes and failures to date, and began to illustrate the overlap between communities planning in each watershed. More detail on town planning efforts can be found in Chapter 2.

A premise of the Section 208 planning process is that all solutions must be on the table. The plan takes into account all technologies and strategies that may be successful on Cape Cod, evaluates each individually and looks for appropriate places for use as part of a watershed scenario. The purpose of watershed scenarios is to set parameters for the discussion of solutions on a watershed basis. The watershed scenarios developed represent a range of possible options. They do not suggest an optimal solution, as decisions on how to proceed must be made locally.

To determine appropriate technologies to consider and build consensus on approaches to watershed planning across town boundaries an existing team – the Technical Advisory Committee (TAC) of the Collaborative - and several new teams - the 208 Plan Update Technologies Panel, watershed working groups, and subregional working groups - were utilized.

COLLABORATIVE TAC

The TAC was re-formed and re-chartered to look at some of the technical aspects of the Section 208 Plan Update. Specifically, the TAC reviewed and commented on the suite of technologies identified through the Water Quality Technologies Matrix (Technologies Matrix) and helped to develop and refine a series of one-page fact sheets for stakeholders and community use. These have been incorporated in the online Technologies Matrix, available at: http://capecodcommission.org/matrix. The TAC consists of one appointed representative from each town and a MassDEP representative to provide the regulatory, permitting and technical perspectives. See Appendix 1C for a list of members and their affiliations.

TECHNOLOGIES PANEL

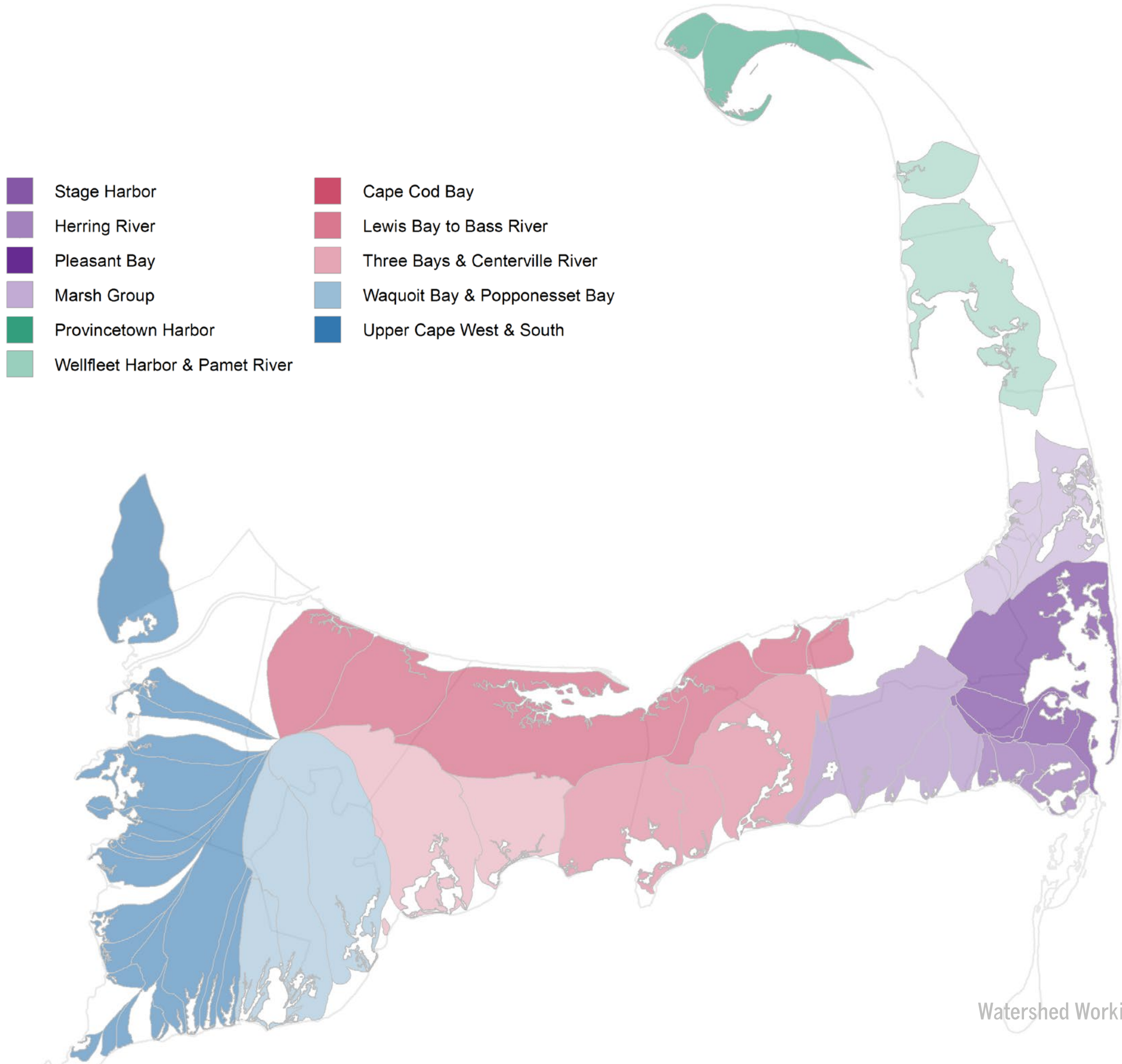
A Technologies Panel, which met four times over the course of two months, was convened to review, confirm, and expand upon the Technologies Matrix, review the overall planning approach in each watershed, and provide input on a site-screening methodology for non-traditional technologies. The panel consisted of local, national, and international experts on the impact of nutrients in coastal waters, remediation approaches, and emerging technologies. See Appendix 1D for a list of members and their affiliations, as well as meeting information.

STAKEHOLDER ENGAGEMENT

For the purposes of planning, the 53 embayment watersheds across Cape Cod were grouped into 11 watershed working groups based on proximity to one another, level of impairment and other hydrogeologic characteristics (see **Figure 1-2** on following page).

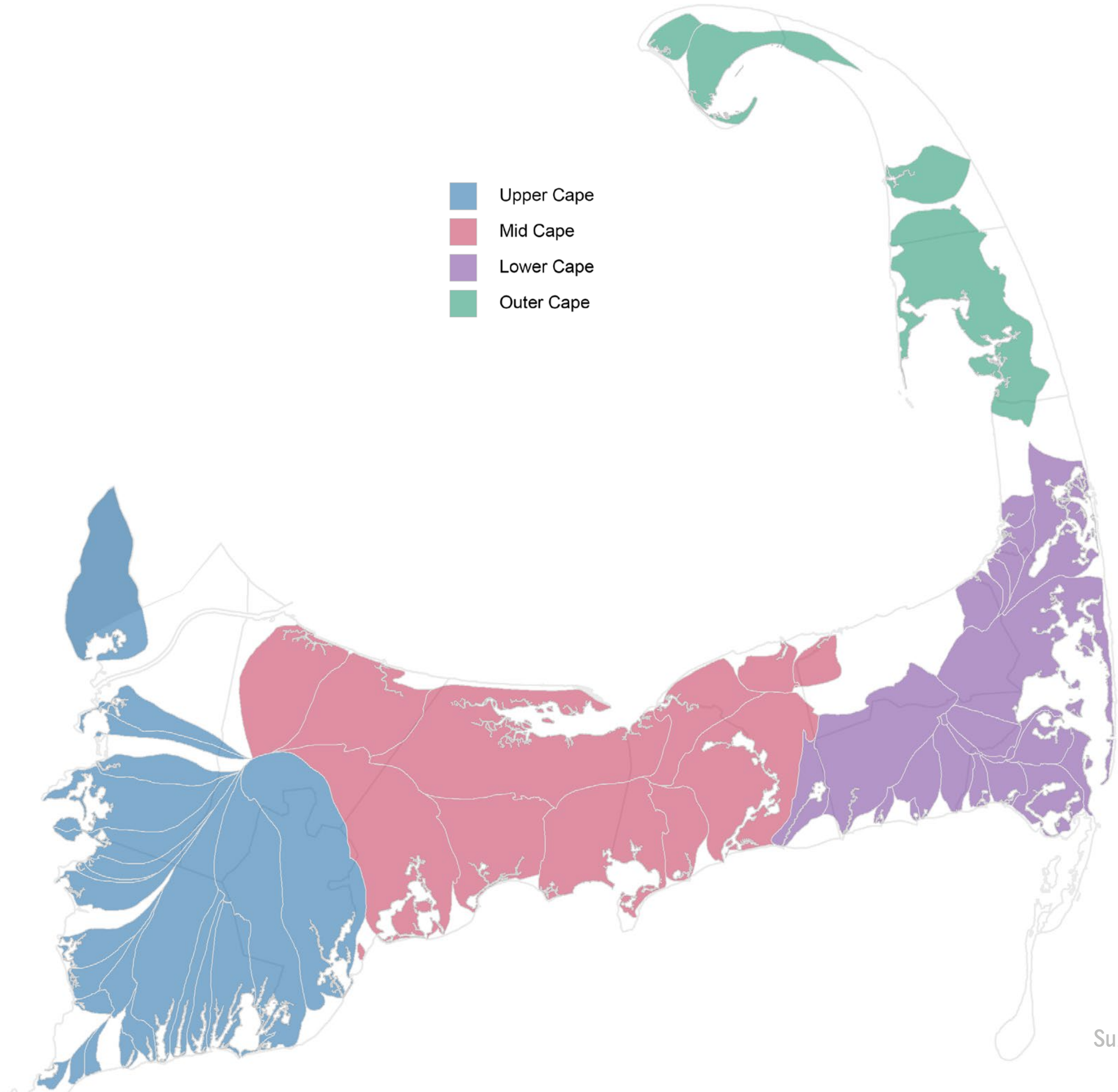
Consistent with the iterative process used throughout development of the Section 208 Plan, the number of watersheds considered in the final plan was reduced from 57 to 53. Four small watersheds are now accounted for within the broader watershed areas to which they contribute.

The watersheds were further organized in to four subregional working groups – the Upper Cape, Mid Cape, Lower Cape, and Outer Cape (see **Figure 1-3** on following page).



Watershed Working Group Boundaries

Figure 1-2



Subregional Boundaries

Figure 1-3

Everyone on Cape Cod is connected in some way to these watersheds. The embayment watersheds make up approximately 79% of the land area on Cape Cod (**Figure 1-4**) and are home to 89% of its residential development and 78% of non-residential development.

Each watershed can be categorized by level of impairment. The scale and diversity of the planning area warranted an extensive and varied group of stakeholders to provide input. **Figure 1-5** shows the watersheds included in each subregion and watershed group along with the general degree of impairment.

Working Groups, made up of 15-20 self-selected stakeholders (about 170 people Cape-wide), are associated with each watershed working group. Each group consists of the following general representation:

- Local Elected Officials
- Wastewater Committee Members
- Town Professional Staff
- Local Business Owners/Operators
- Local Environmental Organizations
- Civic Group Members
- Alternative Technology Interests
- Development/Real Estate Community
- Interested/Concerned Citizens

To start the stakeholder process, two meetings were held in each of the four subregions – one in July 2013 to introduce the process and develop the watershed working groups and one in August 2013 to introduce information around affordability of infrastructure and discuss what residents and business owners on Cape Cod are currently paying for water and wastewater infrastructure. These meetings helped engage communities and identify stakeholders interested in participating in the process.

See Appendix 1E for a full list of the planning areas and the watersheds included in each, as well as the stakeholder group associated with each.

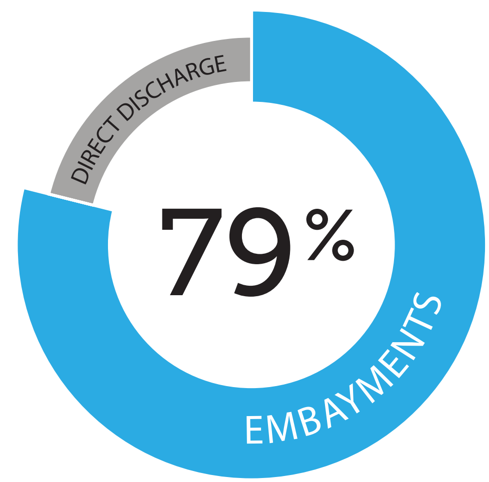
WATERSHED WORKING GROUPS

Each watershed working group met three times in four-hour-long professionally-facilitated meetings in the fall of 2013 - once in September to discuss the baseline information in each of their watersheds, including land use, nitrogen related water quality impairments, pond water quality, existing infrastructure, and proposed infrastructure identified through previous municipal efforts, once in October to discuss the range of technologies and approaches that might be used on Cape Cod, and once in December to discuss the process for applying technologies and approaches in each watershed. See Appendix 1F for a complete list of meeting dates, agendas, and meeting summaries for all of the watershed working group meetings.

SUBREGIONAL WORKING GROUPS

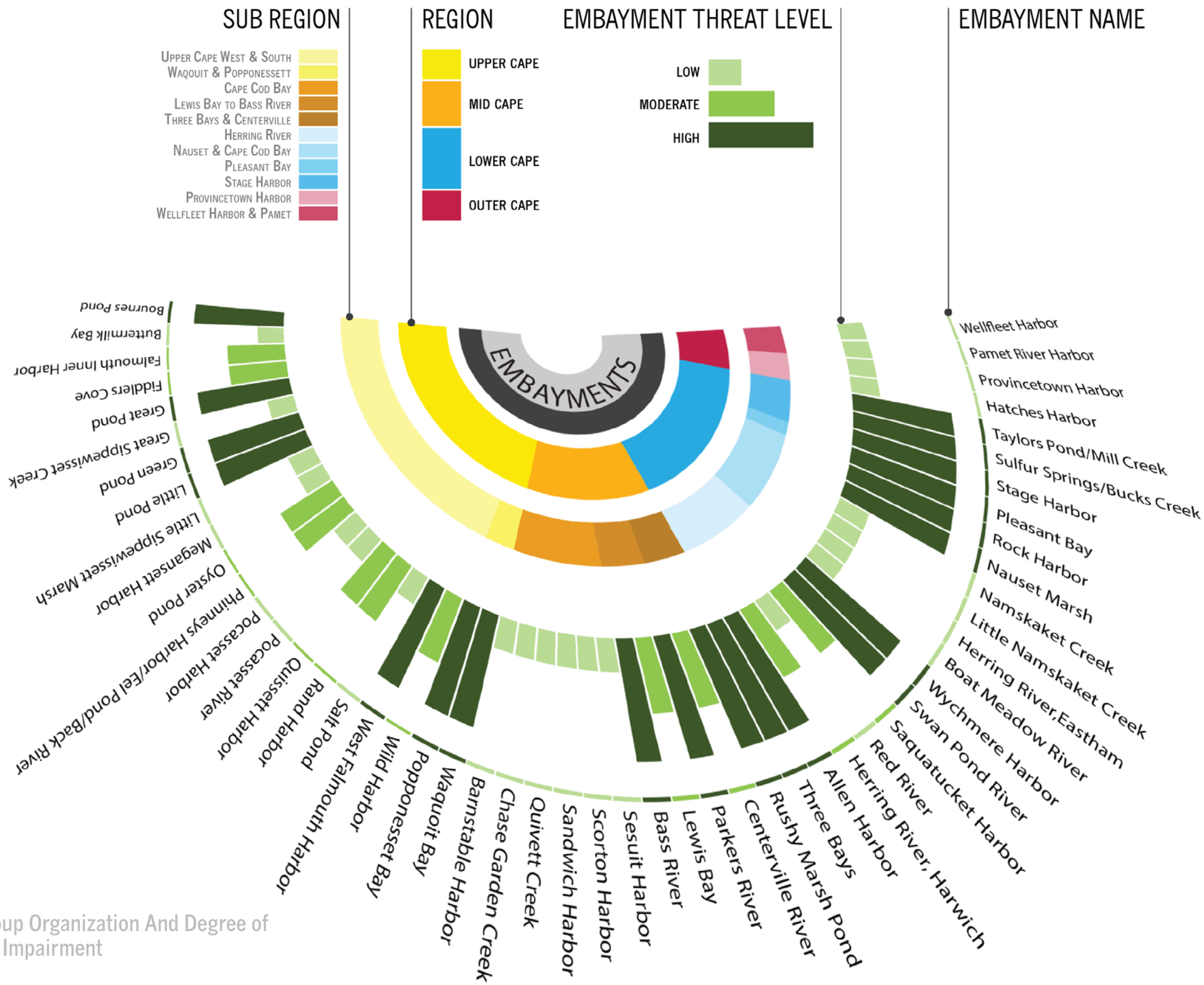
Following the three sets of watershed working group meetings the conversation shifted from discussing the jurisdiction of the problem, at the watershed level, to the jurisdiction of the solution, at the subregional level. In February 2014, the watershed working groups were asked to self-select into subregional working groups, with representation from each of the established categories.

The structure of the subregional meetings was different from the watershed working group meetings, which had discrete topics associated with each. The subregional meetings were iterative, with a standing agenda that included scenario planning, regulatory, legal and institutional issues, and implementation. Meetings included representation from MassDEP and US EPA and were also professionally facilitated by CBI.



Percentage of Cape Cod Land Area that Discharges to an Embayment

Figure 1-4



Working Group Organization And Degree of Embayment Impairment

Figure 1-5

See Appendix 1G for a complete list of meeting dates, agendas, and meeting summaries for all of the subregional meetings.

CHALLENGE: HOW TO ADDRESS THE ISSUE OF AFFORDABILITY

One of the basic principles of the Section 208 Plan Update is that cost be considered as part of every watershed solution and the impact on individual homeowners be a primary concern. If a solution isn't affordable, it's not doable.

In addition to identifying more affordable technologies, it is of the utmost importance to consider how to pay for the needed solutions and identify new resources from the State and Federal Governments to offset the costs.

To help achieve the goals of ensuring affordability for Cape Cod residents and businesses, considering innovative ways to pay for solutions and identifying new resources the Commission established a new team – the 208 Plan Update Finance Committee.

FINANCE COMMITTEE

The Finance Committee met monthly and was convened with representation from local communities and support from consultants to the Cape Cod Commission. Members included a town administrator, a finance director, and a municipal finance committee member. The mission of the committee was to work with the consultants to the Commission to establish a factual basis for discussing issues of affordability, financing, and resources related to the Section 208 Plan Update. See Appendix 1H for a list of members and their affiliations, as well as meeting information.

CHALLENGE: HOW TO ADDRESS THE NEED FOR REGULATORY FLEXIBILITY

The existing regulatory framework was built to solve other problems. Existing regulatory drivers overbuild expensive solutions dependent on pointsource technologies to solve a nonpoint source problem. This approach doesn't account for the unique challenges of Cape Cod as a coastal community with a marine water quality issue caused by nutrients and a relatively low-density development pattern.

To ensure regulatory impediments and flexibility in planning and permitting were addressed the Commission established two new teams – the Section 208 Plan Update Regulatory, Legal and Institutional Work Group (RLI) and the Monitoring Committee.

RLI WORK GROUP

The RLI Work Group had representation from MassDEP, US EPA, the Cape Cod Commission, and other State and Federal partners, as necessary. It addressed the potential need for regulatory reform and other challenges associated with planning and implementation. The need for increased coordination between local, state and federal regulatory requirements was identified by the Commission and the group met monthly to discuss this and other opportunities and challenges related to the Section 208 Plan Update. See Appendix 1I for a list of RLI Work Group members and their affiliations, in addition to meeting information.

MONITORING COMMITTEE

The Monitoring Committee was convened in April 2014 and continues to meet monthly. The mission of the committee is to provide expertise on appropriate monitoring protocols for technology efficiency and total maximum daily loads (TMDLs), while identifying a process for consolidating all available monitoring data in a central location and format. Members include representatives from MassDEP, US EPA, academic institutions, non-profit organizations, and other government agencies. The roles and responsibilities of this committee are to:

- Establish performance monitoring protocols for technologies that may be a part of watershed permits in the future;
- Establish compliance monitoring protocols for meeting TMDLs in the water body;
- Establish a process and structure for consolidating and cooperation of existing monitoring programs and data in to a centralized location; and
- Identify region-wide monitoring needs and develop proposals.

To achieve the benefits of flexible permitting, a plan must remain adaptive in nature. Monitoring the technologies permitted as part of an adaptive management plan is essential to maintaining a flexible regulatory environment

into the future. See Appendix 1J for a list of Monitoring Committee members and their affiliations, as well as meeting information.

CHALLENGE: ENGAGING THE BROADER CAPE COD COMMUNITY

While the number of individuals involved in the effort to update the Section 208 Plan was significant, the broader public still needed to be engaged and educated on water quality issues. In an effort to broaden outreach the Commission developed web-based engagement opportunities and held Cape-wide meetings to provide updates on the problem and process.

WEB-BASED CAPE-WIDE ENGAGEMENT

Cape2O

Between July and December 2013 the Commission ran two online engagement games with the help of the Engagement Game Lab at Emerson College on their Community PlanIt platform (https://communityplanit.org/capecod/). The engagement games, called Cape2O, introduced players to water quality issues on Cape Cod, and touched upon science, civics, economics, our environment and consensus building. The initial game was targeted at seasonal and year-round residents, with the second game targeted at schools. More than 900 individuals registered for the two games, generating more than 6,000 comments and questions on water quality issues. Six local "causes" were awarded $1000 prizes to implement projects on Cape Cod. See Appendix 1K for supporting materials.

www.CCH2O.org

The website www.cch2o.org was developed by the Commission as a portal to raise watershed awareness and enable individuals to better understand various approaches and technologies that may improve water quality on Cape Cod. It was designed to increase the community's understanding of water quality concepts – why water quality problems exist and how they might be improved – through a web-based interactive tool.

Through the website, users are able to locate the watershed in which they live and acquaint themselves with nutrient issues specific to that watershed. The site also provides an opportunity for citizens to examine solutions to water quality problems at individual and community-wide levels. Various links are available to allow users to dig deeper into other web-based tools the Commission has developed and to provide an email address or log in to be updated on the Commission's ongoing efforts.

CAPE-WIDE MEETINGS

On November 13, 2013, the Commission held a Watershed Event to conclude the Cape2O game, award prizes to participants and provide funding to top projects associated with the game. Over 120 stakeholders, Cape2O players, regulatory agency staff, and members of the public attended. Speakers included Cape and Islands Senator Dan Wolf, as well as representatives from the US EPA and MassDEP. In addition to discussing the outcomes of the Cape2O game the time was used to begin the discussion around structuring the second half of the stakeholder engagement process – the subregional working group meetings.

On February 6, 2014, the Commission held a day-long Stakeholder Summit to review the work to date and discuss the path forward toward development of the Section 208 Plan Update. About 270 stakeholders, regulatory agency staff, and members of the public attended the event and speakers included the state treasurer, MassDEP commissioner, CEO of the Cape Cod Chamber of Commerce, representatives from the US EPA and the Cape Cod Commission. The discussion focused on the importance of the community involvement in the Section 208 planning process and the need to meet water quality goals in Cape Cod's estuaries. Breakout sessions included preliminary conversations on scenario planning, regulatory, legal, and institutional issues, and implementation issues, in order to set the stage for the upcoming subregional working group sessions.

See Appendix 1L for all materials related to the Watershed Event and the Stakeholder Summit.

1

Learning from the Community

Complex environmental problems caused in large part from human interaction with the land and natural environment require complex solutions. Solutions for water quality problems on Cape Cod are not only environmental, but social and political as well. Solving this problem requires cooperation among communities and respect for stakeholder perspectives. Stakeholder feedback maintained that one of the greatest challenges to collaboration in shared watersheds is managing disagreement amongst various interests and multiple municipalities in a shared watershed.

As part of the Section 208 Plan Update, the Commission recommends that guidance on managing disagreement among parties be developed.

Recommendation S1.1: The Cape Cod Commission shall develop guidance on managing disagreement among parties.

When many people join together to solve a problem, regardless of the approach taken or model used, there will be different points of view and different strategies proposed. Part of the planning effort should include building mechanisms into the process to solve such disagreement.

Each party should conduct a self-assessment as part of the terms of their collaboration with a focus on each party's ability to define responsibilities and annual objectives. Agreeing to alternative dispute resolution mechanisms, whether formal or informal, creates that mechanism for managing disagreement as it arises. Agreement to such processes may keep the content of such mediations the responsibility of parties themselves, encourage the exchange of information, help parties to understand differing views, shift the focus to the future, invent solutions that meet fundamental interests of all parties, and increase public trust. The goal of such a process would be a mutually acceptable settlement of all issues raised.

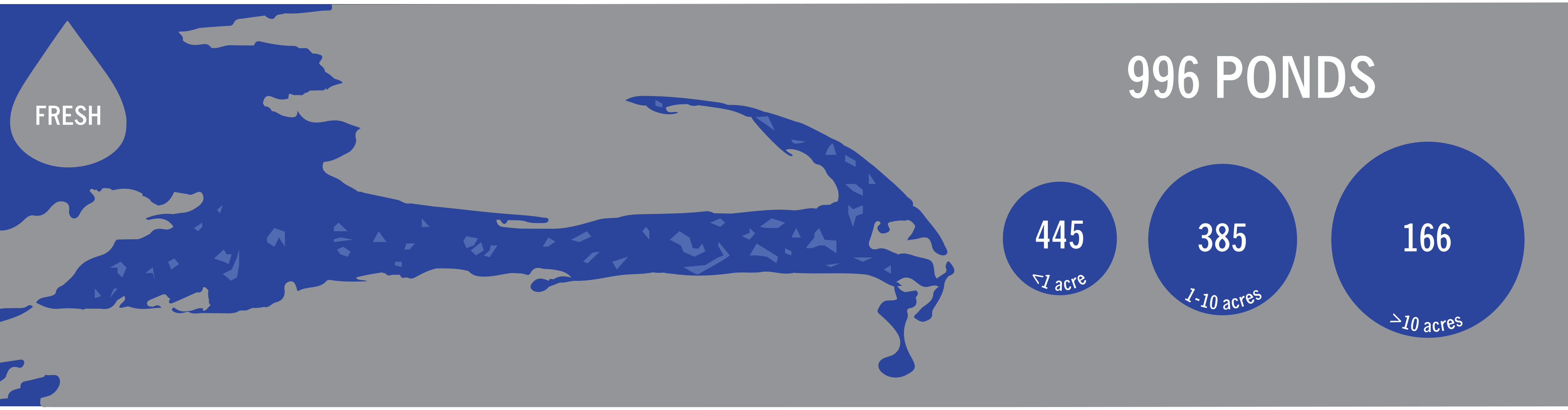
Barnstable County could be considered as a resource for mediation support services. Barnstable County could designate a liaison in each shared watershed to provide support in working through disagreements. These designees could work with town managers, planners or other boards and working groups as a point of contact and provide facilitation service to towns as they implement watershed plans and approaches.

02 PROBLEM

Cape Cod Baseline - People & Place

Cape Cod's great natural beauty, bountiful recreational opportunities and proximity to major urban areas led to a rapid increase in population over the last half century. The region is defined by, and dependent on, the marine environment that surrounds it. The intersection of the region's hydrology with its year round and seasonal population presents specific challenges. Increased residential development built to accommodate the rapid influx of people to Cape Cod depended almost exclusively on individual septic systems, which discharge nitrogen to the groundwater. There are101 watersheds to the surrounding marine waters and of those, 53 are watersheds to coastal embayment systems. The coastal embayments are located at the margin of the aquifer and are the ultimate receiver of the aquifer's groundwater discharge.


MARINE
CAPE COD BAY
ATLANTIC OCEAN
BUZZARDS BAY
NANTUCKET SOUND

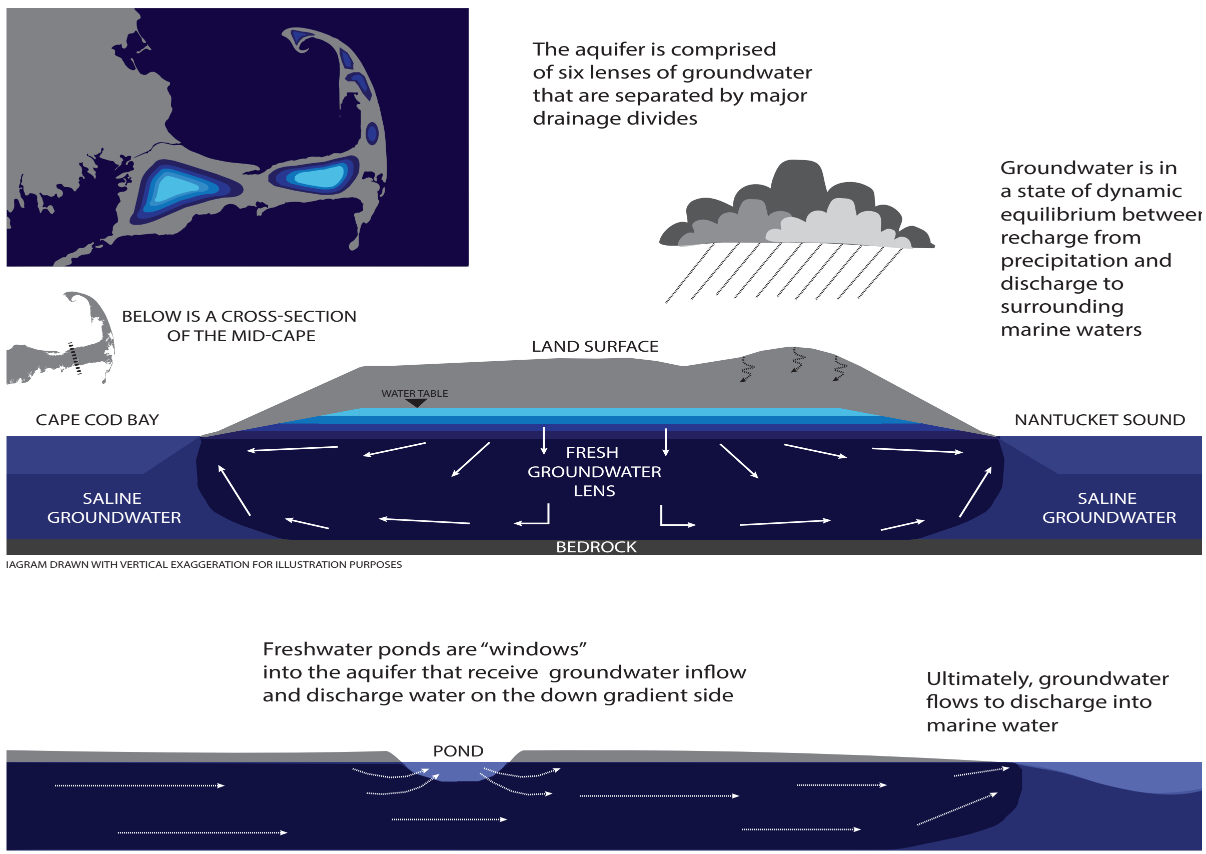

FRESH
996 PONDS
445
<1 acre
385
1-10 acres
166
>10 acres


GROUND
1
AQUIFER

PHYSICAL SETTING: WATER ON CAPE COD

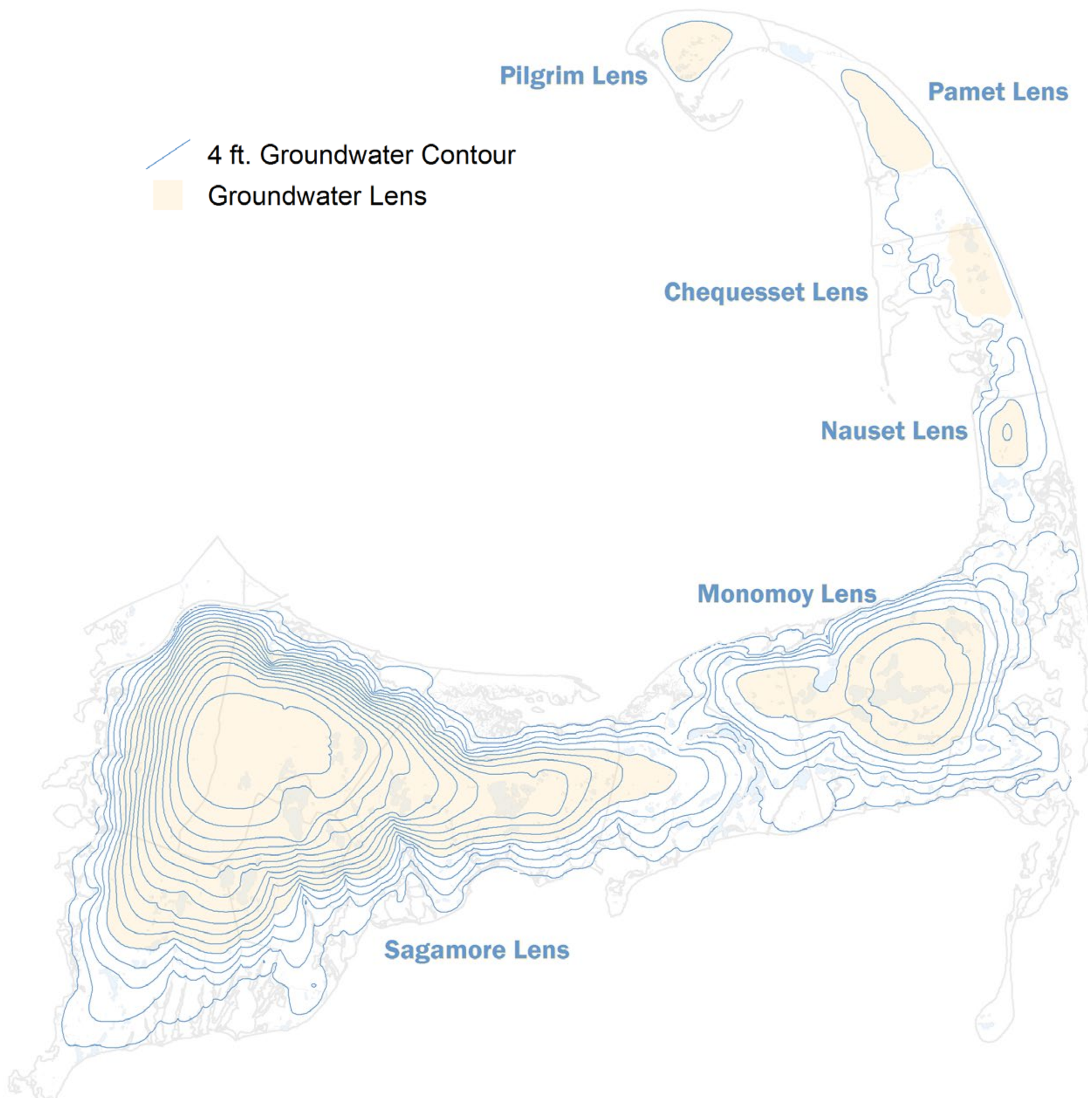
Cape Cod is an iconic peninsula, only 10 miles at its widest point. It is completely surrounded by marine water, including Cape Cod Bay, the Atlantic Ocean, Nantucket Sound, and the Cape Cod Canal. Cape Cod also hosts 996 freshwater ponds covering 11,000 acres of its land area. The fresh water beneath the land is called groundwater.

Cape Cod is a sand and gravel remnant of the last continental deglaciation that occurred 15,000 to 20,000 years ago. The Cape is a series of broad gently sloping outwash plains that are truncated by long linear moraine deposits found along the present day Route 6/Mid-Cape Highway from Sandwich to Orleans and Route 28/MacArthur Boulevard through Bourne and Falmouth. The glacial deposits are approximately 150 to 900 feet thick from Buzzards Bay to Provincetown and are generally coarse to medium sand, but grade to finer materials at depth. The coarse sands are extremely permeable making for a high yielding groundwater system (**Figure 2-1** illustrates the groundwater system).



Groundwater

Figure 2-1



Water Table Map of Cape Cod

Figure2-2

The groundwater of Cape Cod is bounded at the top by the water table which is ubiquitous across the Cape, a sharp transition zone between fresh and marine water at the shore, and by bedrock below, except for the Outer Cape where freshwater lens floats on top of saltwater.

The groundwater system is recharged solely from precipitation at a rate of 27 inches per year (approximately 60% of precipitation). The groundwater system is in dynamic equilibrium between recharge and discharge to the surrounding marine waters and flows at approximately one foot per day due to gravity. Groundwater located further inland has a greater distance to travel to get to the shore, therefore, the accumulation of recharge over time mounds up. The mounds of groundwater are relatively thin and convex and therefore are referred to as lenses of groundwater.

Six separate lenses comprise the Cape Cod aquifer system: the Sagamore Lens is the groundwater system for the Upper and Mid Cape region, the Monomoy Lens for the Lower Cape and the Nauset, Pamet, Chequesset, and Pilgrim Lens for the Outer Cape. (see **Figure 2-2**).

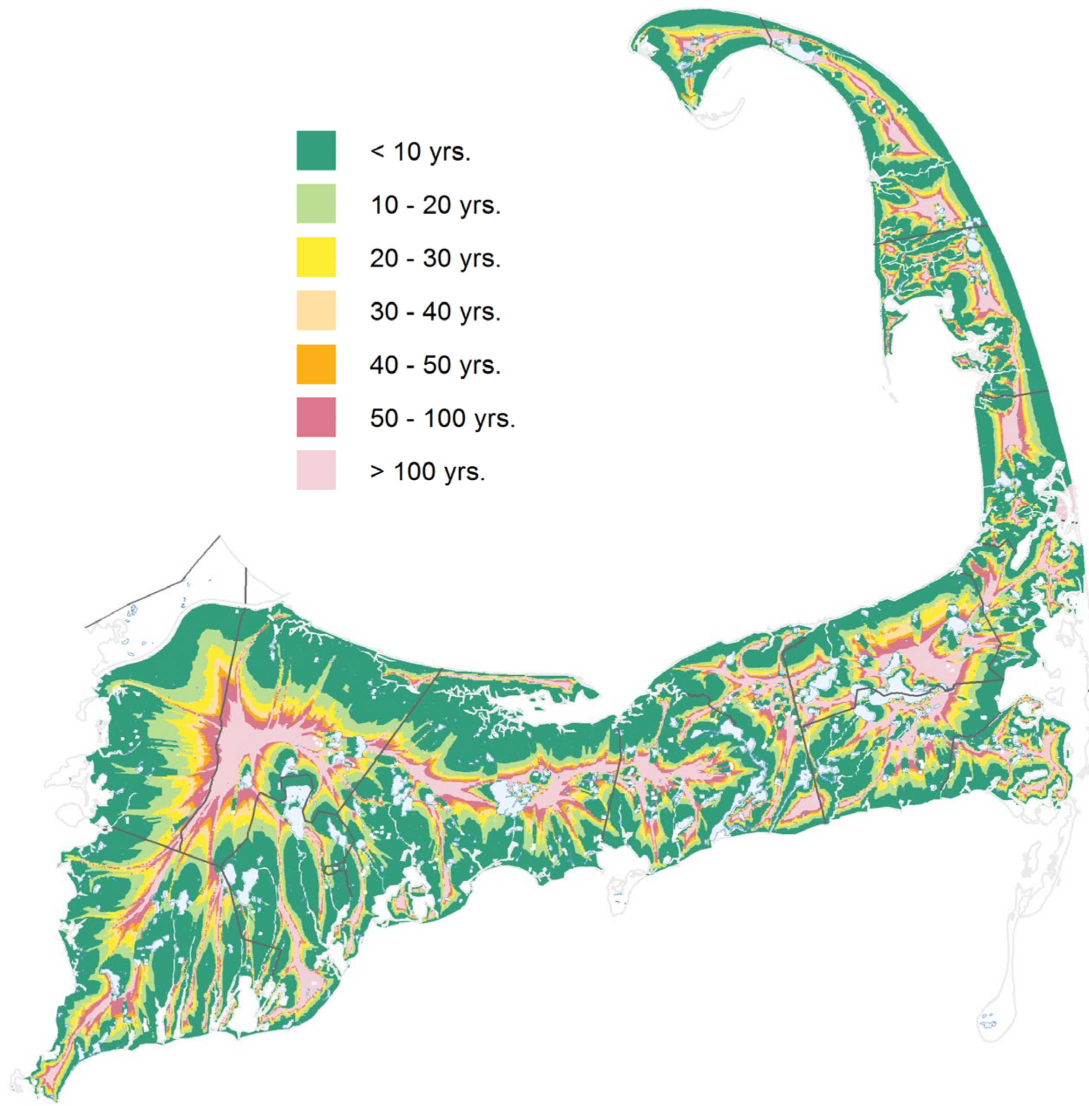
The Cape's groundwater system is directly connected to the fresh and surrounding marine systems. It is susceptible to contamination from various land uses and activities as described in later sections.

Figure 2-3 shows the groundwater time-of-travel areas on Cape Cod, as delineated by the United States Geological Survey (USGS), indicating the years required for a particle to travel from its point of entrance to the groundwater to Cape Cod's coastal embayments.

Travel time is less than 10 years for almost half of Cape Cod's land area. This presents the likelihood that wastewater treatment options, once implemented in these areas, could result in water quality improvements within 5-10 years in some degraded embayments.

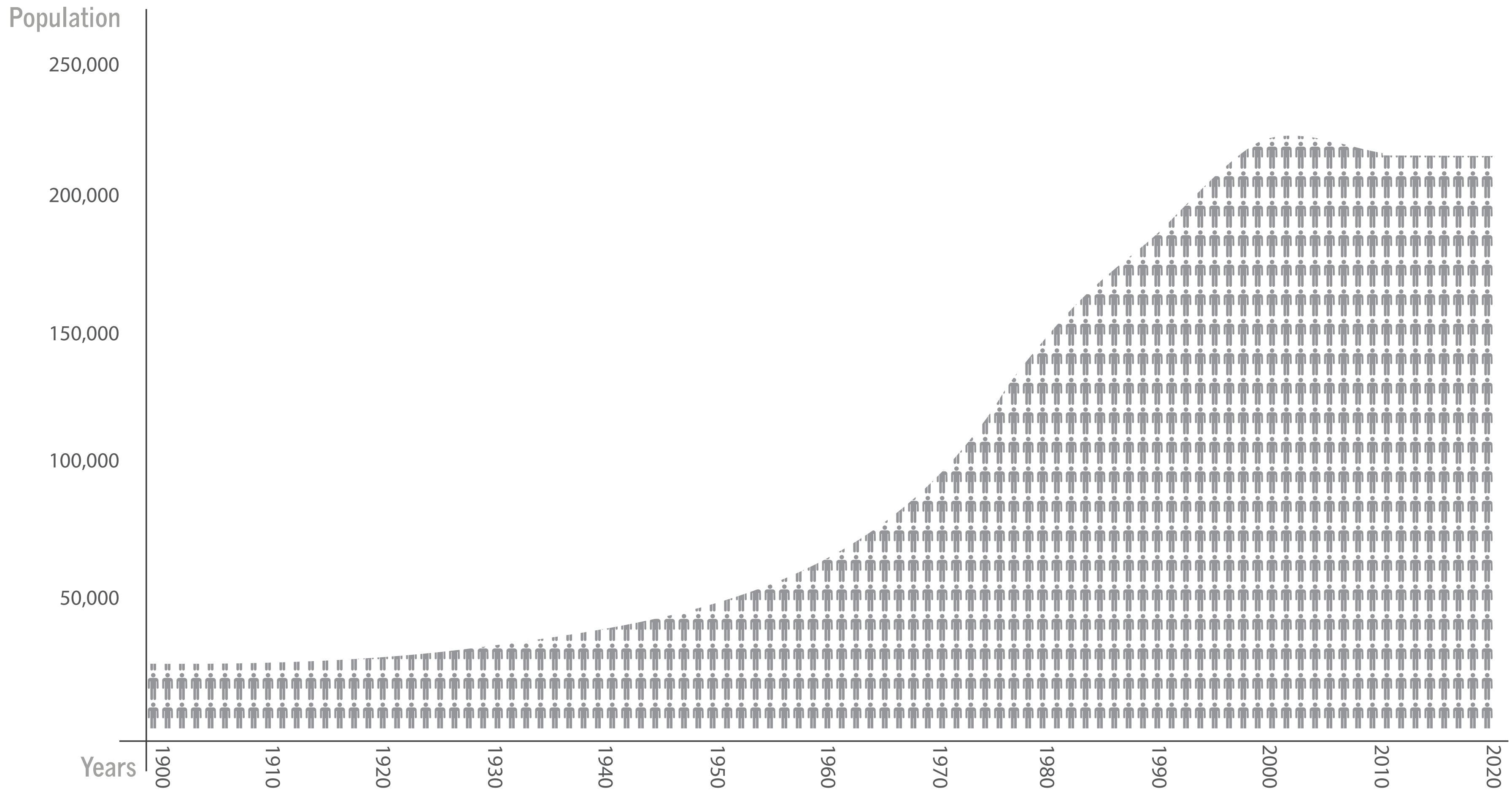
LAND USE: POPULATION, DENSITY, AND SEASONALITY:

Land use on Cape Cod has changed over time due in part to fluctuations in population. The Cape's traditional farming and fishing way of life underwent a slow transformation from the 1870s through the early part of the 20th century as seaside resorts began to attract summer visitors. The advent of rail travel and the adoption of the interstate highway system added to the accessibility and the popularity of Cape Cod.



USGS Time of Travel Map

Figure 2-3



Total Population Barnstable County

Figure 2-4

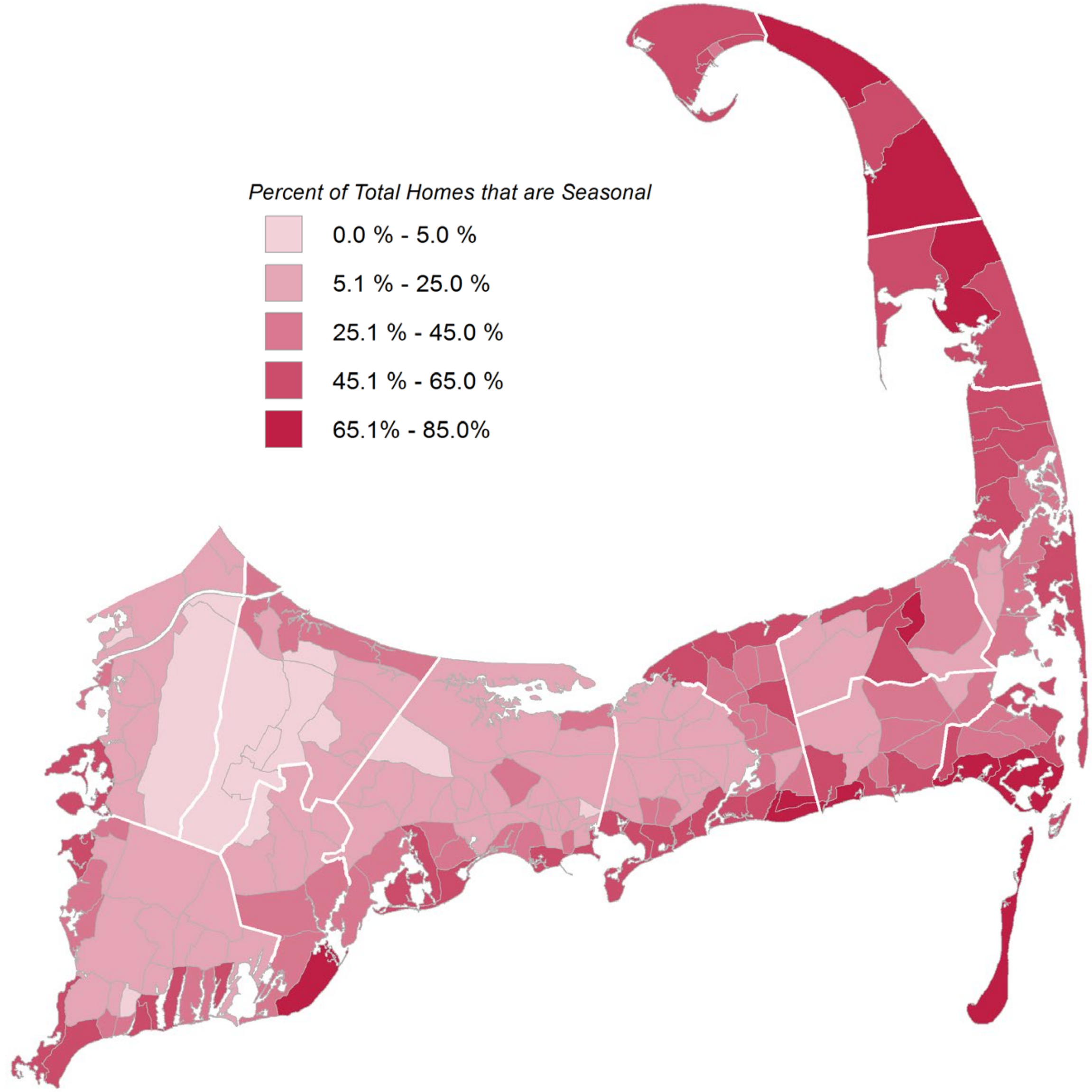
The population began to rise more quickly in the 1950s and even more steeply from the 1970s through the early 2000s, as Cape Cod became a desired location for retirees and second-home buyers (see **Figure 2-4**).

During this time period, the population of Cape Cod swelled 400%. In 1951, just prior to the swell in population, most of the interior of Cape Cod remained open space and the coasts were developed as dense residential areas. By 2012, the interior of the Cape Cod peninsula was consumed by residential units (**Figure 2-5** through **Figure 2-13**). Recently, population decreased from about 227,000 in 2001 to an estimated 215,000 in 2011. The decline is attributed, in part, to the increasingly high cost of Cape Cod real

estate as the market boomed in the last decades of the 20th century, followed by the swift market decline toward the end of the first decade of the 21st century.

These striking changes in population and land use are also apparent in density patterns on Cape Cod. Based on 2010 Census data, the density of human habitation is 582 people per square mile, nearly five times that in 1950 (118 people per square mile). Furthermore, the density in 2010 is far from uniform; people are clustered together in specific areas on the land surface. There are as few as 36 people per square mile in many protected areas, such as the National Seashore on the Outer Cape, state parks and Wellhead Protection Areas. In highly dense areas, such as Hyannis, there are as many as 4,500 people per square mile. The density of housing units mirrors the non-uniformity of human habitation on Cape Cod. Areas such as Falmouth, Barnstable and Provincetown, have larger numbers of people and more housing units per square mile than other parts of the Cape.

There is a seasonality to the population on Cape Cod. In the past several decades the number of people living year-round on Cape Cod increased, with a corresponding conversion of seasonal homes for year-round use. Approximately one third of the housing stock on Cape Cod (57,000 housing units) is dedicated to seasonal use. Seasonal units are non-uniformly distributed over the land and are much more prevalent in coastal areas than inland areas (**Figure 2-14**).



Seasonality

Figure 2-14

Cape Cod Land Use 1951

Cape Cod Land Use 1971

Cape Cod Land Use 1985

Cape Cod Land Use 1999

Cape Cod Aerial Image 1952

Cape Cod Aerial Image 1971

Cape Cod Aerial Image 1984

Cape Cod Aerial Image 2002

Cape Cod Land Use 2012

Figure 2-9

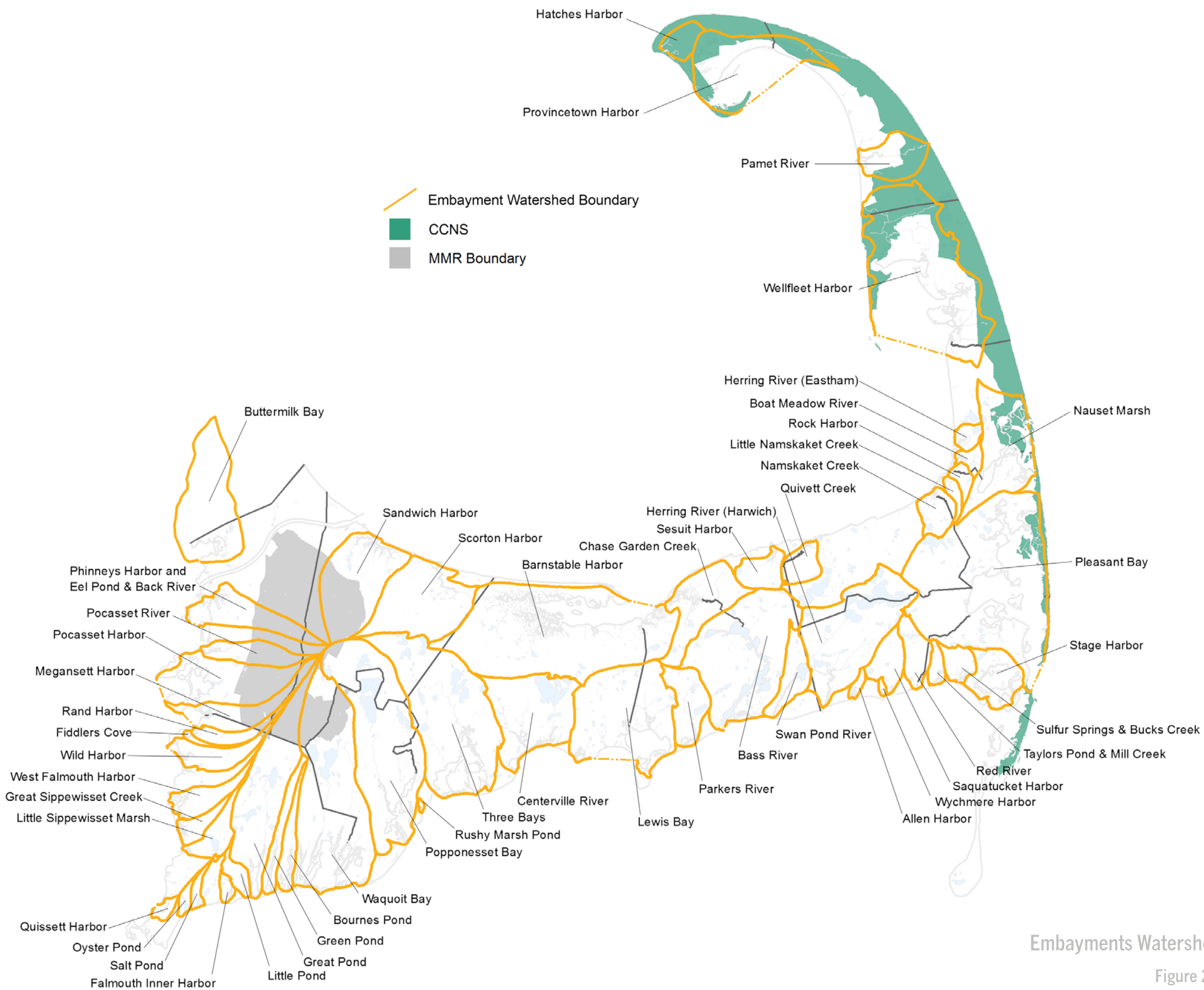
Facing page, from left to right:

Figure 2-5 Cape Cod Land Use 1951
Figure 2-6 Cape Cod Land Use 1971
Figure 2-7 Cape Cod Land Use 1985
Figure 2-8 Cape Cod Land Use 1999

Facing page, from left to right:

Figure 2-10 Cape Cod Aerial Image 1952
Figure 2-11 Cape Cod Aerial Image 1971
Figure 2-12 Cape Cod Aerial Image 1984
Figure 2-13 Cape Cod Aerial Image 2002

2

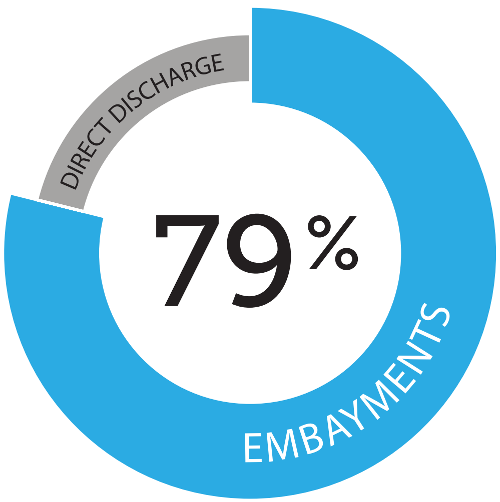


Embayments Watersheds

Figure 2-15

THE INTERSECTION OF PEOPLE AND PLACE

The intersection of the region's hydrology with its year round and seasonal population presents specific nutrient pollution challenges. Increased residential development built to accommodate the rapid influx of people to Cape Cod depended almost exclusively on the construction of individual septic systems. Individual on-site septic systems are documented as the greatest contributing factor to declining estuary and embayment water quality. In the following sections, marine, fresh and ground water systems will be reviewed with specific attention to water quality issues.



Percentage of Cape Cod Land Area that Discharges to an Embayment

Figure 2-16

MARINE WATER

Cape Cod hosts 101 watersheds that drain into surrounding marine waters. A watershed is a geographic area separated from other regions by drainage divides. Within each watershed area, water flows to an embayment or other water body. Fifty-three watersheds on Cape Cod drain into coastal embayment systems. Coastal embayments, partially enclosed coastal areas with varying degrees of tidal restriction, are located at the margin of the aquifer and are the ultimate receiver of the aquifer's groundwater discharge. Embayments are important ecosystems on Cape Cod; they are the primary habitat for shellfish, spawning grounds for fish stocks, and important recreational areas for Cape Cod residents and visitors.

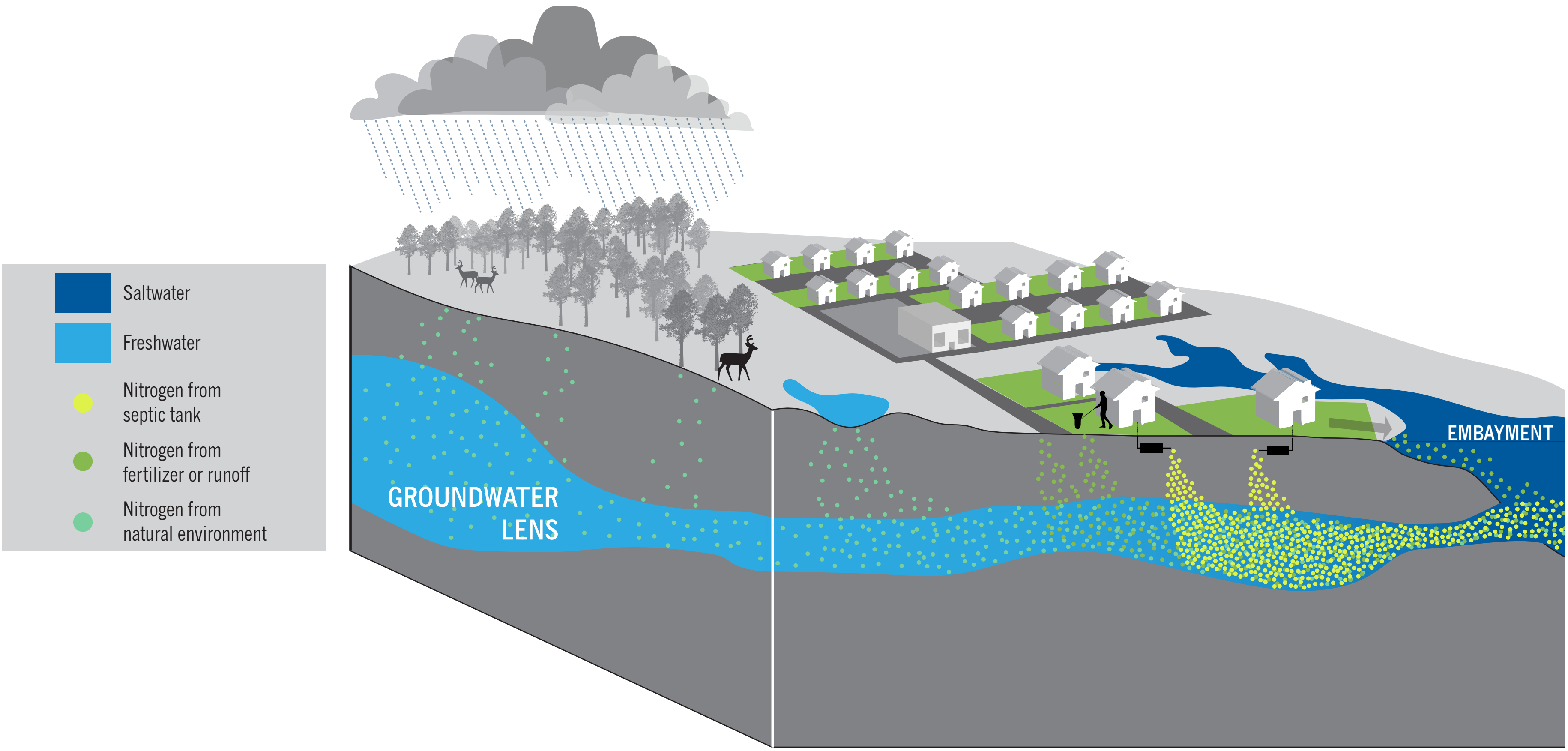
Each watershed, with its associated coastal embayment, extends from the top of the water table lens to the coastline, covering nearly 79% of the land area of Cape Cod (see **Figure 2-15** and **Figure 2-16**). The remaining 21% of Cape Cod is in a watershed where groundwater discharges directly to open coastal water such as the Cape Cod Canal, Nantucket Sound, Cape Cod Bay and the Atlantic Ocean. These are called direct discharge areas and are important areas to consider for potential wastewater discharges since the nitrogen loads do not impact the coastal embayments.

MARINE COASTAL WATER QUALITY

Watersheds are vulnerable to pollutants generated by land uses. Residential development in the last several decades sprawled across Cape Cod, consuming open space and dispersing wastewater throughout the aquifer. Nitrogen, a nutrient in wastewater, stormwater, and fertilizer, percolates into groundwater and ultimately discharges at the coast (**Figure 2-17**). The impact of nitrogen on coastal embayments is a major cause for concern on Cape Cod. Wastewater from septic systems was found to be the primary source of nitrogen overloading the coastal embayments.

In healthy embayment ecosystems, eelgrass is the dominant plant type and survives on sparse amounts of nitrogen. However, when too much nitrogen is added to an embayment, excessive algae is produced, resulting in large algal mats that shade out eelgrass and destroy animal habitat, which eventually leads to a loss of shellfish. This is referred to as the process of eutrophication. In some cases, severe conditions of anoxia have occurred that also result in fish kills and aesthetically unpleasing conditions.

TThe maximum amount of a pollutant that a water body can receive and still meet water quality goals is defined as a Total Maximum Daily Load (TMDL) under the Federal Clean Water Act. As described in guidance from the United States Environmental Protection Agency (US EPA), a TMDL identifies the loading capacity of a water body for a particular pollutant. US EPA regulations define loading capacity as the greatest amount of a pollutant that a water body can receive without exceeding water quality standards. Recent Cape Cod TMDLs have focused on nitrogen.TMDLs are established to protect and/or restore the estuarine ecosystem, including eelgrass, the leading indicator of ecological health. TMDLs are technical planning documents. Federal, state and local authorities implement



Contributing Nitrogen to Coastal Embayments

Figure 2-17

TMDLs through various legal instruments such as state groundwater discharge permits and National Pollution Discharge Elimination System (NPDES) permits.

Concurrent with the beginning of our awareness about the effect of nitrogen in coastal waters, the Commission adopted a regulatory requirement that development projects within watersheds to impaired embayments must have no-net nitrogen loading. In other words, the amount of nitrogen added by a project must be offset by an equivalent reduction. Several County-appointed committees that reviewed the Commission's regulatory program accepted this requirement as a necessary interim step to halt continued degradation of the Cape's coastal water quality. Over the years, it became increasingly clear to organizations involved in assessing and protecting embayments that a comprehensive effort to link regulatory and scientific activities was necessary to realize solutions for observed coastal water quality problems.

The general science to define critical thresholds and TMDLs advanced considerably over the past two decades. Efforts include defining watersheds, estimating watershed nitrogen loads, collecting water quality data, modeling tidal flushing and evaluating ecosystem interactions between embayment species. One project spearheading these efforts is the Massachusetts Estuaries Project.

MASSACHUSETTS ESTUARIES PROJECT

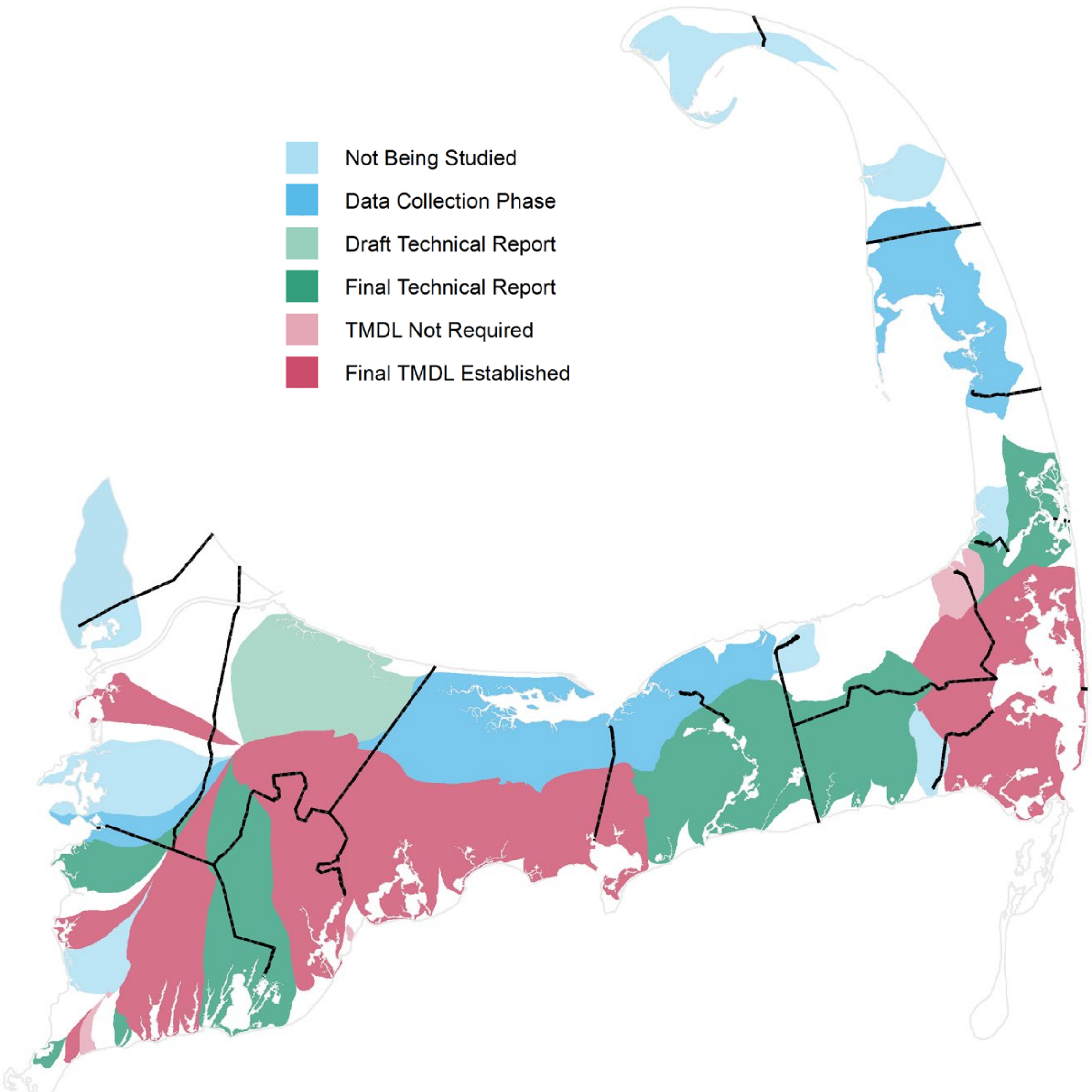
In 2001, the Massachusetts Department of Environmental Protection (MassDEP) and the University of Massachusetts-Dartmouth, School of Marine Science and Technology (SMAST) began the Massachusetts Estuaries Project (MEP). The MEP was estimated to cost $12 million over six years. Funding is broad-based with half coming from the state and the other half coming from local and other agency and non-profit sources. Barnstable County, through the Cape Cod Commission and the Cape Cod Water Protection Collaborative, provided over $700,000 to the MEP over the last eight years as direct assistance to participating Cape Cod towns. The MEP resulted in technical reports and documents that have been approved by state, federal, and county regulatory agencies. The MEP's regionally consistent methodology provides technical work and documents at significant cost savings over towns undertaking similar work individually.

The MEP developed a rigorous linked-model approach that includes components of the various disciplines necessary to understand and project how nonpoint source nitrogen loading in a watershed can result in coastal water quality deterioration. Data input into these models includes: at least three years of volunteer-collected coastal water quality data, tidal flushing data, bathymetric information for estuaries and freshwater ponds, pond water quality data, current and historic eelgrass coverages, water use information, wastewater treatment plant performance, landfill monitoring data, watershed delineations, sediment nutrient regeneration, and wetland nitrogen attenuation.

MEP Report Status and Findings

The MEP provides specific documentation that many of Cape Cod's watersheds have impaired water quality and ecological damage due to nitrogen loading. The results of many technical reports were used to develop federal- and state-approved TMDLs. As of February 2015, 35 watersheds have completed MEP technical reports, two are in draft form, and four are pending. There are 12 embayments not scheduled for study by MEP because nitrogen is not believed to be a critical issue due to tidal flushing, low intensity development, or geomorphology. US EPA approved 12 TMDLs for embayments on Cape Cod. One additional TMDL is currently pending final US EPA approval. MassDEP is drafting additional TMDLs based on MEP technical reports. The results of the technical reports have been adopted as the federal and state approved TMDLs, which makes them the basis for watershed nutrient management. **Figure 2-18** shows the status of the technical reports and TMDLs by watershed.

Although the amount of nitrogen entering the watershed is an important consideration in evaluating the potential impact on coastal embayments, other factors such as tidal range and embayment volume play significant roles. Embayments on the southern coast of Cape Cod are more susceptible to impacts because the tidal range is approximately three feet while the range observed in Cape Cod Bay is nine feet. Therefore, more water is available to dilute and remove nitrogen loads in the Cape Cod Bay embayments than the southern embayments.



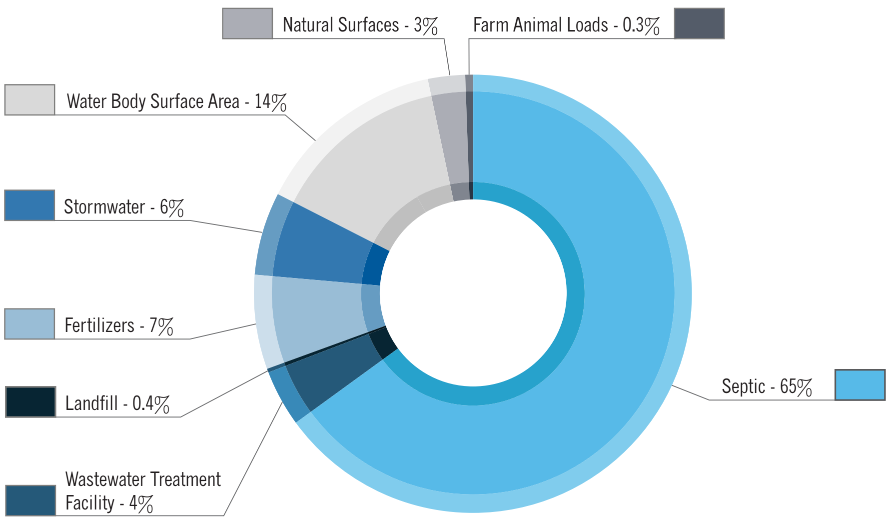
Status of MEP Technical Reports and TMDLs by Watershed

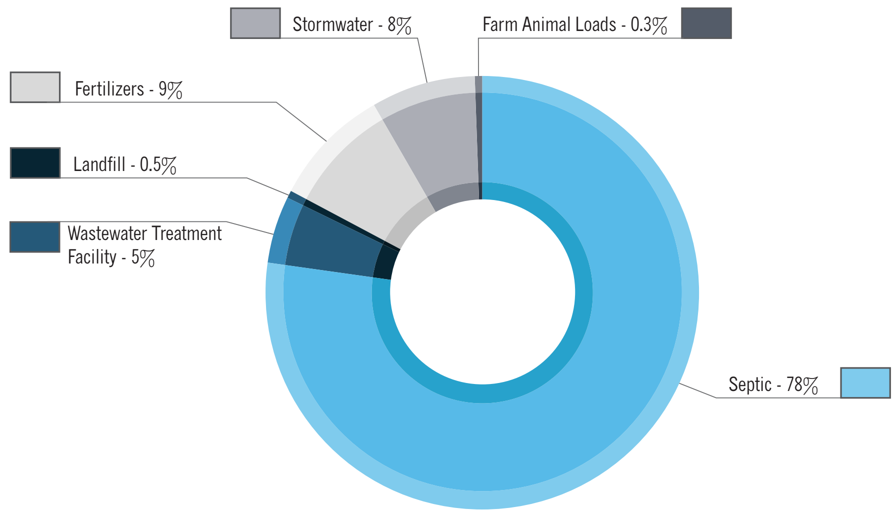
Figure 2-18

MEP Peer Review

In response to concerns raised by some Cape Cod communities regarding the validity of the MEP scientific approach, the Barnstable County Commissioners directed the Cape Cod Water Protection Collaborative to undertake a scientific peer review of the MEP process. In 2011, the Collaborative organized an independent scientific peer review of the MEP methodology for developing appropriate TMDLs for the estuaries and embayments of Cape Cod, and for the use of that methodology as a basis for wastewater and nutrient management planning and implementation on Cape Cod. The scientific peer review process was independent and objective, and operated externally from the Collaborative and from any other Cape Cod stakeholders.

The peer review panel found the MEP modeling approach to be appropriate and useful for evaluating alternative scenarios and informing nutrient management plans, and also found the MEP to be consistent with existing nationwide TMDL practices. The panel also found that the MEP modeling approach is scientifically credible, and the modeling approach is consistent with current understanding of existing conditions for Cape Cod estuaries, based on available data. The components in the approach are well known and documented. Computation of watershed nitrogen loads is strongly data-driven and quantitatively linked to estuarine nitrogen concentrations. For more information see the MEP Peer Review Executive Summary or the full report of the MEP Scientific Review Panel on the Cape Cod Water Protection Collaborative website (www.ccwpc.org).





Total Nitrogen Sources by Percentage

Figure 2-19

Controllable Nitrogen Sources by Percentage

Figure 2-20

Controllable and Total Loads

The MEP provides specific documentation, based on water quality testing and ecological habitat assessments, indicating that many of Cape Cod's embayments have impaired water quality and ecological damage due to nitrogen loading. The MEP identifies the primary controllable nitrogen sources as wastewater, fertilizer and stormwater. Smaller sources include treated wastewater, landfills and farm animal waste. Septic nitrogen accounts for nearly 80% of the controllable nitrogen load in Cape Cod embayments. **Figure 2-19** and **Figure 2-20** show a Cape-wide breakdown of nitrogen sources for total load and controllable load, respectively.

Some TMDL reports approved by the US EPA include nitrogen loads to natural surfaces and water body surface areas as controllable. The MEP technical reports and TMDL reports approved by the US EPA estimate the total load of nitrogen in a watershed and specify how much needs to be removed to meet the TMDL. Since septic system contributions account for most of the controllable nitrogen load in each Cape Cod watershed, the MEP technical reports and TMDL reports also specify how much septic system nitrogen alone would need to be removed to meet the TMDL. The average reduction rate for septic nitrogen load to meet water quality standards exceeds 50% Cape-wide.

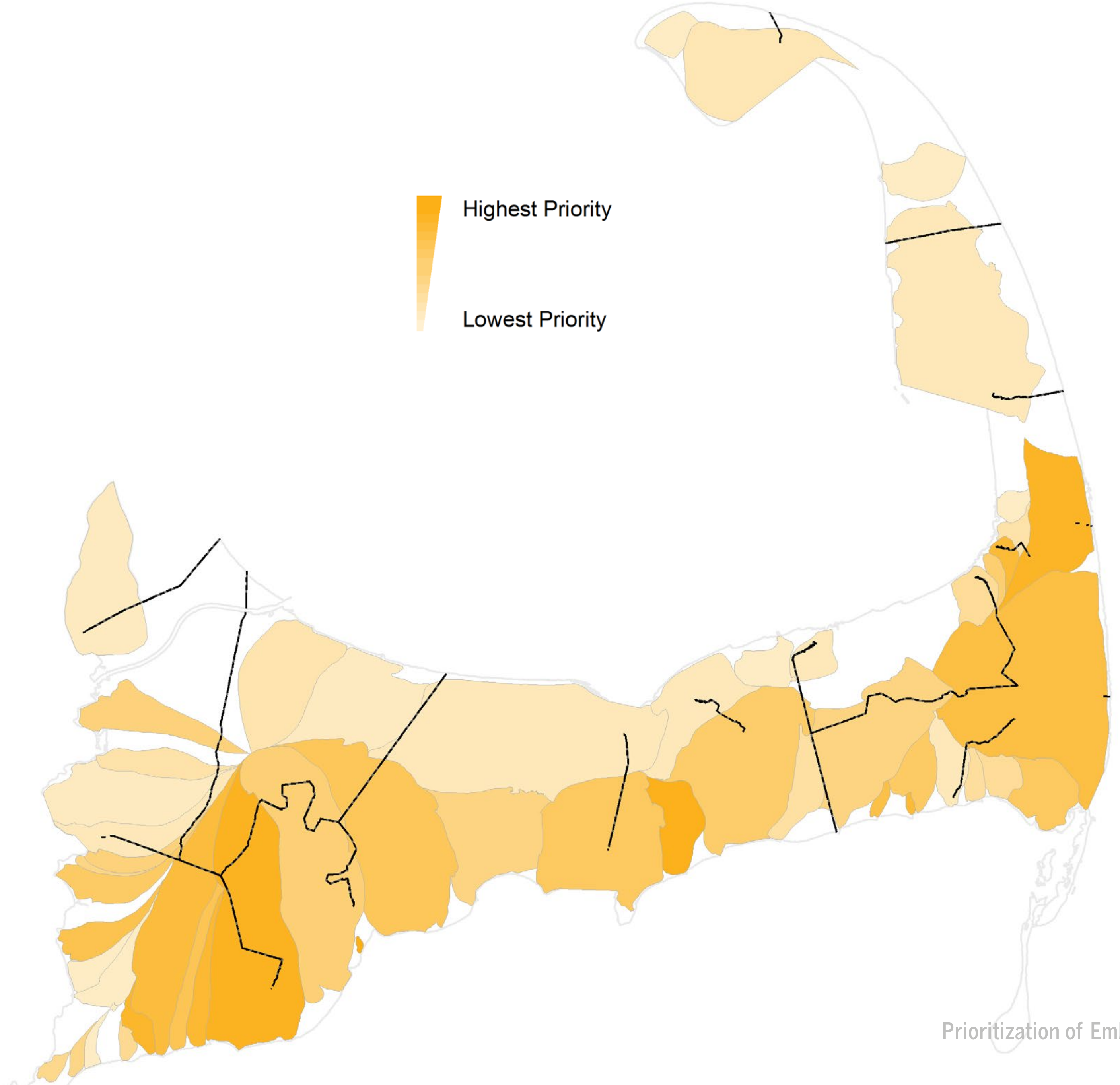
CRITERIA	SCORE	SCORE DEFINITION	DATA SOURCE
Habitat	4	Severe Degradation	Ecological health section of MEP technical reports
	3	Significant Impairment	
	2	Moderate Impairment	
	1	Healthy Habitat Conditions	
% Septic Nitrogen Removal Required after Attenuation	4	Upper quartile (>80%)	Critical nutrient threshold section of MEP technical reports
	3	Upper mid quartile (52-80%)	
	2	Lower mid quartile (35-52%)	
	1	Lower quartile (<35%)	
% Nitrogen Attenuated by Natural Processes	4	Lower quartile (<4%)	Watershed nitrogen load section of MEP technical reports
	3	Lower mid quartile (4-11%)	
	2	Upper mid quartile (11-21%)	
	1	Upper quartile (21-44%)	
Total Nitrogen Load	4	Upper quartile (25,400-85,000 kg-N/yr)	Watershed nitrogen load section of MEP technical reports
	3	Upper mid quartile (9,060-25,400 kg-N/yr)	
	2	Lower mid quartile (2,810-9,060 kg-N/yr)	
	1	Lower quartile (<2,810 kg-N/yr)	
CWMP Status	4	Preferred plan identified but not implemented	Local CWMPs
	3	Alternatives identified	
	2	Needs assessment conducted or MEP technical report completed	
	1	CWMP approved and being implemented	
	0	No CWMP or none anticipated	
Regional Opportunity	3	All municipalities in shared watershed contribute significant nitrogen load to the embayment	MEP nitrogen loads and local water use data
	2	Only one municipality in shared watershed contributes significant nitrogen load to the embayment	
	1	Watershed is wholly within one municipality	
(High ranking and score = higher priority for study)			

Watershed Priority Ranking Criteria

Table 2-1

As a means of identifying a prioritized list of watersheds for study, criteria were established to rank watersheds by subregion (Upper Cape, Mid Cape, Lower Cape, and Outer Cape). Ranking criteria included habitat, total nitrogen load, percent septic nitrogen removal required after attenuation (natural nitrogen reduction), percent nitrogen attenuated by natural processes, CWMP status, and regional opportunities. **Table 2-1** provides details on each of the ranking criteria.

Using the above criteria, watersheds are ranked and prioritized for planning (**Figure 2-21**). All of the embayment watersheds are impacted by nitrogen loading from their watersheds or are at risk for future impairment and should have access to State Revolving Fund (SRF) loans. This prioritization is strictly for planning purposes and not for prioritizing where resources should be made available. Appendix 2A provides specific ratings and scores for each watershed shown in the map. The data used to develop these scores will be updated as new information becomes available.



Prioritization of Embayment Watersheds

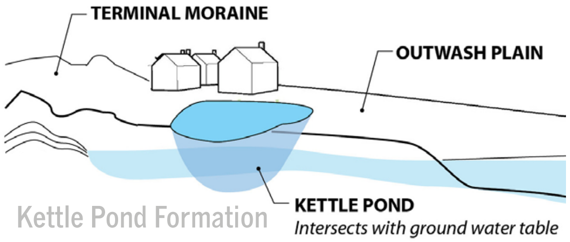
Figure 2-21

Ponds

Figure 2-23

FRESHWATER

Lakes and ponds on Cape Cod formed about 12,000 years ago during the Wisconsinan glaciation. As glaciers retreated from Cape Cod, large pieces of ice were left behind. When these pieces of ice melted, the area above each collapsed forming large depressions in the land called kettle holes (**Figure 2-22**). These land depressions dip below the water table, creating the hundreds of ponds seen today.



Kettle Pond Formation

Figure 2-22

Typically, ponds lack a surface water inlet or outlet. Instead, there is a steady inflow and outflow of water between the ponds and the adjacent aquifer, which is why scientists often refer to freshwater ponds as windows into the aquifer. As part of the regional aquifer system, the ponds are directly linked to drinking water and coastal estuaries, as well as any pollutants added to the aquifer.

Cape Cod has 996 ponds covering nearly 11,000 acres (see **Figure 2-23** and **Table 2-2**). These ponds are highly variable in size, ranging from less than one acre to 735 acres, with the 21 biggest ponds making up nearly half of the total Cape-wide pond acreage. Approximately 40% are less than one acre and 166 are designated as great ponds of 10 acres or more (Cape Cod Ponds and Lakes Atlas, 2003).

Freshwater ponds are an important part of the Cape Cod ecosystem. They provide critical habitat for freshwater fish species, including: perch (yellow and white), brown bullhead, pumpkinseed, bass (largemouth and smallmouth), banded killifish, American eel and alewife. Ponds also provide resources for people. Year round and seasonal residents use ponds for recreational activities such as swimming, boating and fishing. Recent property values and sales show that demand for pond-front properties is increasing and use of existing residences is intensifying.

In 2001 the Cape Cod Commission, for a coalition of groups interested in protecting ponds, known as the Ponds and Lakes Stewardship (PALS) project, received a $30,000 grant from the Massachusetts Watershed Initiative to develop a Cape Cod pond stewardship strategy.

The Cape Cod Pond and Lake Atlas, published by the Cape Cod Commission in 2003, provides a status report on the PALS program. The Atlas documents the outreach and education activities leading to the creation of the PALS program and reviews water quality data collected by volunteers during the 2001 PALS Snapshot from over 190 ponds. This data was used to develop Cape Cod-specific indicators of pond impacts. Along with data collected in previous studies, the atlas details further efforts necessary to move pond protection and remediation forward on the Cape. The section on Pond Water Quality below includes a summary of the results and products of the PALS efforts.

LARGEST PONDS

Pond	Town	Acres
Long	Brewster/Harwich	743
Mashpee-Wakeby	Mashpee	729
Wequaquet	Barnstable	654
Great Herring	Bourne	373
Johns	Mashpee	338

DEEPEST PONDS

Pond	Town	Depth (feet)
Mashpee-Wakeby	Mashpee	95
Cliff	Brewster	84
Ashumet	Falmouth	84
Long	Brewster/Harwich	72
Long	Falmouth	66

MOST COMMON NAMES

Name	Number of Ponds with Name
Mill	10
Long	9
Flax	8
Grass or Grassy	7
Round	6
Lily	6

NUMBER OF PONDS BY TOWN

Town	Total	>10 Acres
Barnstable	185	27
Bourne	72	6
Brewster	76	22
Chatham	43	8
Dennis	57	6
Eastham	23	5
Falmouth	143	24
Harwich	62	19
Mashpee	57	9
Orleans	63	4
Provincetown	31	3
Sandwich	63	10
Truro	21	5
Wellfleet	29	7
Yarmouth	71	11
Total:	996	166

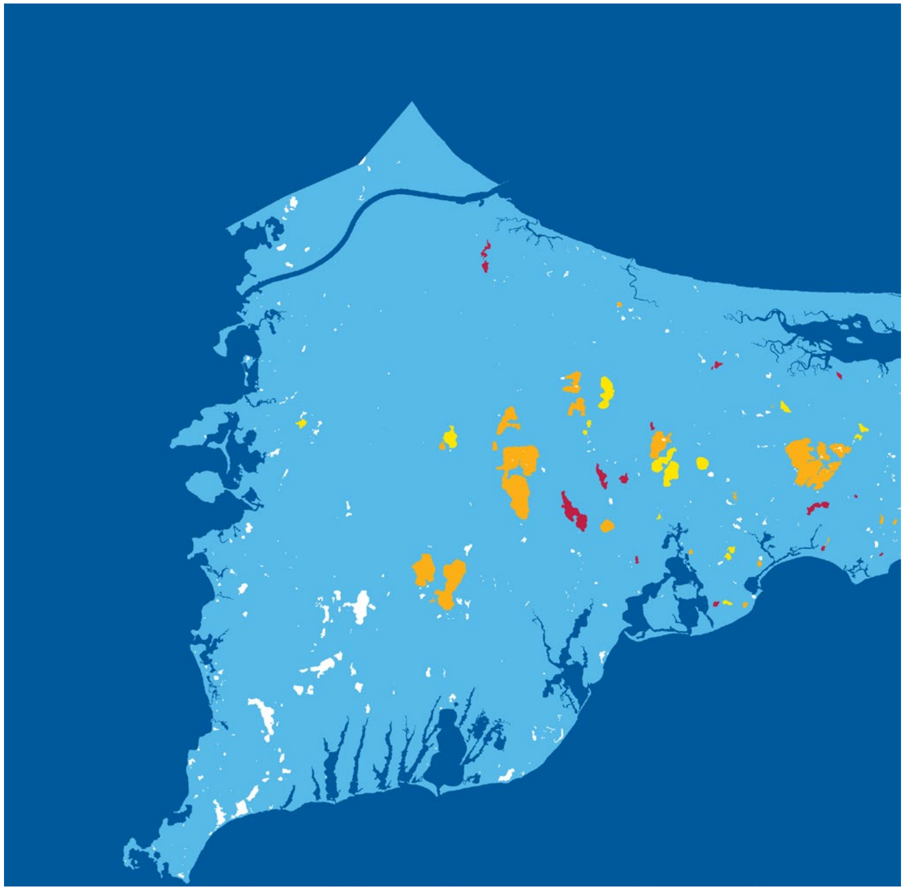
UNIQUE NAMES

Flying Squirrel, Cat Swamp Pond, Widger Hole,Chigger Pond, Pinkwink Pond, Doanes Bog Pond, Canawa Pond.

SOURCES: Cape Cod Commission GIS, Pond and Lake Stewardship (PALS) 2001 Water-quality Snapshot, Massachusetts Department of Fish and Game

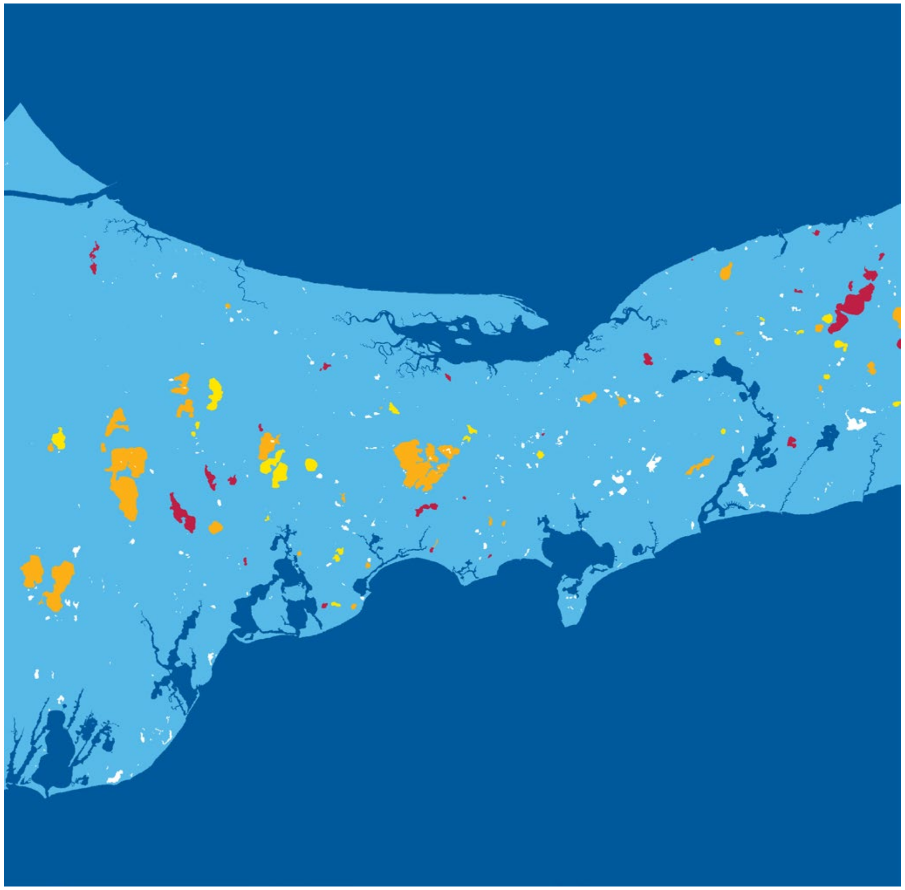
Cape Cod Pond Information

Table 2-2



Upper Cape Pond Trophic Status

Figure 2-24



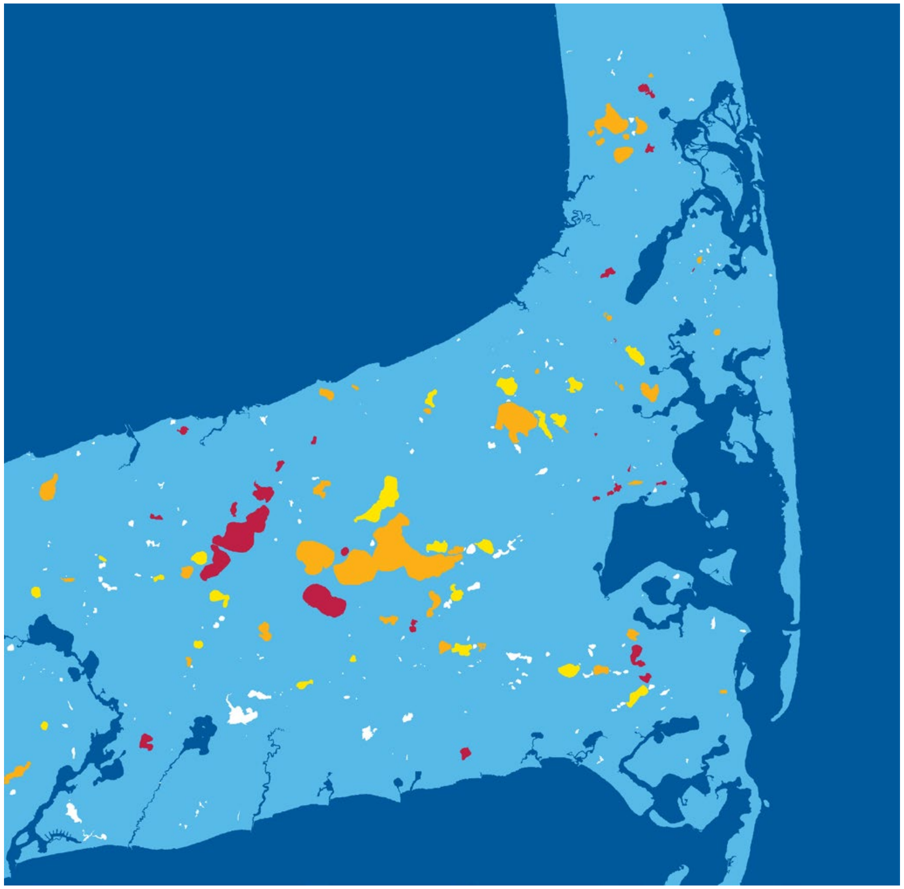
Mid Cape Pond Trophic Status

Figure 2-25

POND WATER QUALITY

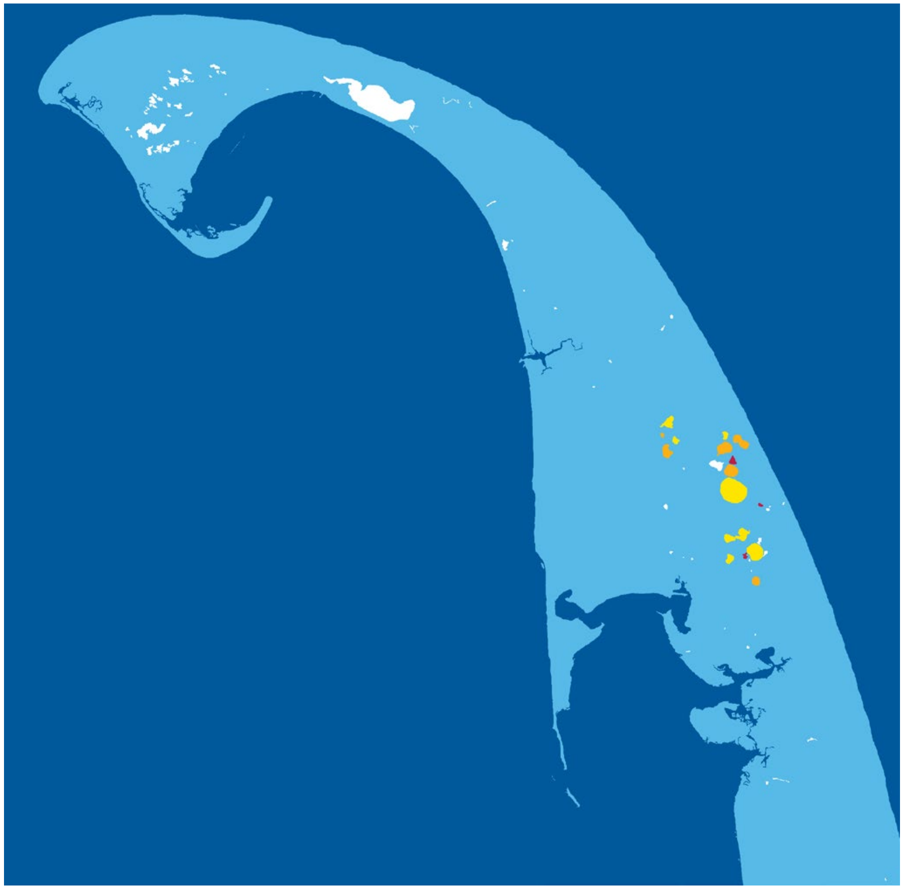
Freshwater ponds are fragile systems and their water quality is significantly impacted by surrounding land development. The soils lack the geological buffering to neutralize acid rain and allow pollutants to drain rapidly. The slow buildup of nutrients from surrounding land use and development impacts ponds through the process of eutrophication, but it can be difficult to detect and abate. The key nutrient of concern for freshwater ponds is phosphorus. Physical impacts to ponds also result from the loss of shoreline buffers as pond front property is developed, lawn area increases, and shorelines erode.

The Massachusetts Department of Environmental Protection established Surface Water Quality Standards (314 CMR 4.00), which are briefly discussed below (www.mass.gov/eea/docs/dep/water/resources/07v5/12list2.pdf). These standards are the basis for listed freshwaters under the 303(d) list for impaired waters. There are 19 fresh water ponds on Cape Cod presently listed on the



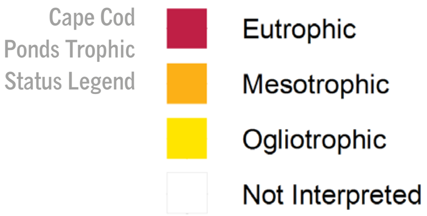
Lower Cape Pond Trophic Status

Figure 2-26



Outer Cape Pond Trophic Status

Figure 2-27



2012 Massachusetts Integrated List. Of these, 16 ponds are Category 5 Waters requiring a TMDL. Impairment causes include, but are not limited to, excess algae growth, phosphorous, turbidity, chlorophyll a, Secchi Disk transparency, abnormal fish histology, non-native aquatic plants, mercury in fish tissue, and dissolved oxygen.

A comparison of 2001 dissolved oxygen concentrations from the Cape Cod PALS project with concentrations measured in 1948 suggests that many of these pond ecosystems are not only impacted, but also seriously impaired (see **Figures 2-24** through **2-27**). Based on information in the Pond Atlas, between 74% and 93% of the Cape's ponds are impacted by surrounding development or uses.

Based largely on dissolved oxygen information, approximately 45% of all ponds and 89% of the deepest ponds are impaired. The findings suggest that the low dissolved oxygen concentrations observed in the ponds are not "natural" conditions, but are the reflection of 50 years' worth of impacts from surrounding development and land use.

Freshwater ponds play a role in coastal watershed nutrient budgets. They are credited with reducing 50% of the nitrogen load headed toward marine embayments through the process of attenuation. Freshwater ponds are surface water resources that wastewater management plans should include as part of a comprehensive analysis of local water quality. The following provides a general background on the number, condition and significant regional and local efforts to assess and manage these resources.

The annual PALS Snapshot monitoring program has continued every year since 2001 through the continued collaboration of local, county and state university programming and includes a database of over 3,500 samples for 195 ponds in all 15 towns. As part of the overall PALS program, SMAST continues to provide laboratory services at no cost to towns or volunteers for the annual PALS Snapshot of pond water quality. Many towns take advantage of the opportunities presented by the annual PALS Snapshots, and expanded their town monitoring programs. These local efforts and additional funding by the Barnstable County Growth Management Initiative enabled a number of additional lake and pond assessments to be completed in the past decade.

These reports include town wide and pond specific assessments:

- Ashumet Pond, Mashpee (2000)
- Bakers Pond, Orleans (2001)
- Long Pond Brewster (2001)
- Cedar Pond, Orleans (2003)
- Flax Pond, Harwich (2004)
- Orleans Ponds (2006)
- Indians Pond, Barnstable Assessment (2006)
- Harwich Ponds (2007)
- Great Sands Lake, Harwich (2007)
- Barnstable Ponds (2008)
- Lovers Lake and Stillwater Pond, Chatham, (2008)
- Dennis Ponds (2009)
- Brewster Ponds (2009)
- Eastham Ponds (2009)
- Lake Wequaquet, Barnstable (2009)
- Santuit Pond, Mashpee/Barnstable (2010)
- Scargo Lake, Dennis (2011)
- Hinckley Pond, Harwich (2012)

Water quality degradation of Cape Cod lakes and ponds has numerous causes, but most are linked to increased nutrient loads associated with shoreline development. Management strategies identified to lessen future impacts from development include: in-pond restoration using alum or oxygen infusion devices; establishing minimum setbacks for septic systems, roads and lawns; providing natural buffer strips between lawns and ponds; treatment of direct and near shore stormwater runoff; and continued public education. The state prepared a Generic Environmental Impact Report on pond restoration alternatives that is used by towns to streamline permitting of restoration projects. The Cape Cod Regional Policy Plan requires a 300-foot buffer for Title 5 leaching systems from pond shorelines. The 300-foot buffer is used for calculating phosphorus budgets from septic systems because phosphorus is rapidly attenuated in groundwater. If a pond is significantly impacted by surrounding septic systems, a reduction of nutrients through wastewater management may be necessary. Any management plan must include continued sampling and monitoring of conditions within the pond.

Although snapshot water quality data collected over the past decade indicate significant ecological impacts, most ponds still provide the majority of uses that Cape Codders desire. Bacterial testing of ponds has generally indicated healthy conditions for swimming. Fishing and boating are still popular and recent property values and sales show that demand for pond-front properties is increasing.

Regular stocking of deep ponds sustains trout fisheries, but trout generally do not have adequate habitats to make it through a summer due to lack of oxygen in the cold waters of deeper ponds. Increased nutrients generally favor bass fishing, but half of the 18 ponds tested for mercury now have health warnings about consumption of fish tissue.

Actions to correct these ecological impairments will depend on community and state priorities. Active discussion of ecological management strategies for these ponds may lead to refinement of pond users' expectations for habitat and recreation and future TMDLs for ponds.

Despite data gathered by citizen monitoring groups and assessments that document water quality impairment, the state has listed only a few freshwater ponds on the 303d list for impaired waters for nutrients under the Clean Water Act. Additional dialogue is needed between the towns, state and county to evaluate the best use of the information collected and how it should be incorporated into the Commonwealth's clean water program.

GROUNDWATER/DRINKING WATER

The Cape Cod aquifer is one of the most productive groundwater systems in New England. It is a sole source aquifer providing drinking water to a daily summer peak of more than 500,000 people. There are 17 separate water districts or departments across Cape Cod. All together there are 158 gravel pack municipal water supply wells, one surface reservoir and hundreds of private wells. Approximately 85% of Cape Cod is serviced with public water. The remaining 15% rely on private or small volume wells in the communities of Sandwich, West Barnstable, Eastham, Wellfleet and Truro. Since 2000, public community drinking water suppliers have pumped, on average, about 10.7 billion gallons of groundwater per year from Cape Cod's sole source aquifer. Over the last decade, pumping has been fairly consistent, only showing slight variations due to seasonal climatic variations. Studies by the USGS indicate that groundwater pumping is equivalent to approximately 10% of the annual recharge from precipitation.

The Cape Cod Commission analyzed water use data from municipal water suppliers. The total amount of water use was confirmed by comparing 2008 to 2010 data from water suppliers to the total amount reported in the Annual Statistical Reports that suppliers submit to the MassDEP. The results indicate that public water suppliers provide 9.3 billion gallons of water per year to Cape Cod. Applying average water use rates for residential and non-residential uses to parcels served by private wells adds 1.2 billion gallons of water per year for a total of 10.5 billion gallons of water per year. These numbers can be converted to water use in gallons per day (gpd) per residential lot. The average residential per lot water use on Cape Cod is 169 gpd. The average non-residential water use is 586 gpd.

Information about water use is essential to planning for wastewater infrastructure. The amount of water use by parcel is fundamental data that is used to estimate wastewater generation. The MEP convention is that approximately 90% of the water used by a household ends up as wastewater.

DRINKING WATER PROTECTION

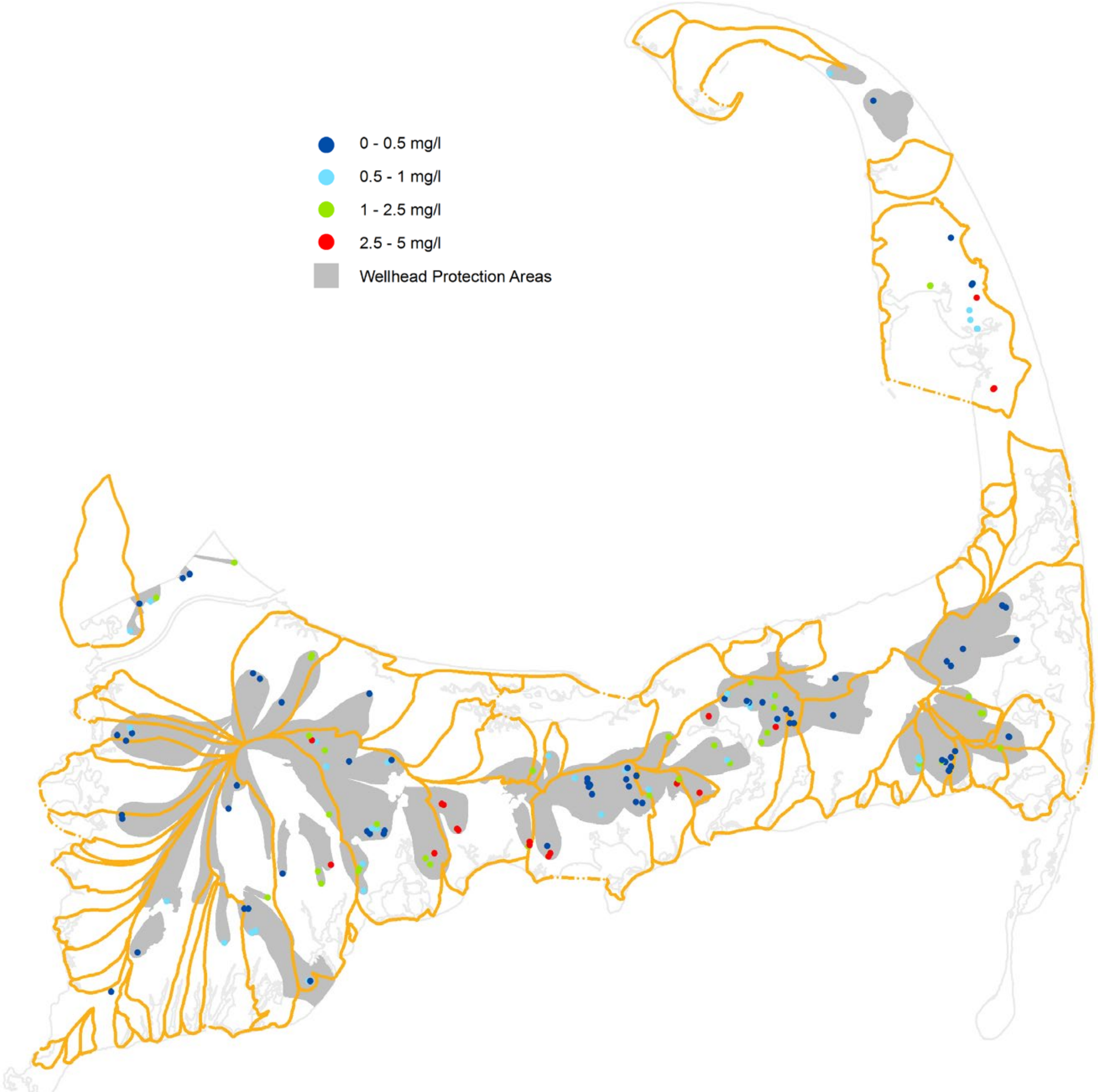
The Cape Cod Aquifer is extremely susceptible to contamination from various land uses and activities. The aquifer has been seriously impacted in the past from military activities, gas stations, landfills and a host of other activities. These examples led to strategies to protect the aquifer at all levels of government and spawned a vigorous industry for the assessment and clean-up of contaminated groundwater. The drinking water of Cape Cod is generally well protected as a result of these activities.

Over the last several decades water planners combined their knowledge of groundwater with policy mechanisms to protect Cape Cod drinking water. Adoption of wellhead protection areas (or Zone IIs) was a major strategy to protect the land area that receives precipitation to recharge the pumping wells. Today each town has zoning and Board of Health bylaws to protect their wellhead protection areas, which are collectively shown in **Figure 2-28**.

In addition, the public embraced acquisition of land for protection of wellhead areas through local, regional and state actions like the Cape Cod Land Bank (later the Community Preservation Act). The Wellhead Protection Area state regulations (310 CMR 22) and Cape Cod Regional Policy Plan (RPP) minimum performance standards prohibit or limit land uses that are potentially detrimental to drinking water quality.

GROUND WATER QUALITY ISSUES

Nitrate, a major component of human wastewater, passes through septic systems virtually untreated and is introduced to the underlying groundwater. Nitrate concentration is often used as an indicator of drinking water quality. A maximum contaminant limit (MCL) of 10 parts per million (ppm) of nitrate for drinking water supplies has been established by the US EPA and adopted by Massachusetts state



Wellhead Protection Areas

Figure 2-28

regulation. The limit was established to protect infants from methemoglobinemia, or "blue-baby" syndrome, a potentially fatal blood disorder that can occur when too much nitrate limits the amount of oxygen in the blood. The RPP established a nitrogen loading concentration of 5 ppm to ensure that nitrate levels in drinking water will not approach the 10 ppm federal standard.

Massachusetts Drinking Water Regulations (310 CMR 22.00) define two types of public drinking water supplies - community and non-community. Community public supply wells include large municipal wells pumping over 100,000 gpd, but also include small volume wells that serve at least 25 year-round residents or at least 15 service connections used by year-round residents. The small volume wells include service to schools, town halls, and community centers mostly located in the Outer Cape that lack large municipal wells. Anything not covered by the definition of community is served by non-community or private wells. Non-community public supply wells fall in to two categories - non-transient and transient. A non-transient non-community public supply well regularly serves at least 25 of the same persons or more for approximately four or more days per week, more than six months or 180 days per year, such as a school. Transient non-community public supply wells serve 25 different persons at least 60 days of the year. Some examples of these types of systems are restaurants, golf courses and community centers. The quality of Cape Cod's community public drinking water supply is generally very good. The percentage of community public supply wells that had nitrate levels at or below 0.5 ppm, which is considered very good, fell from 57% to 42% between 1993

and 2008. Even well protected community public water supply wells have elevated concentrations of nitrate derived from septic systems and other nonpoint sources.

Small volume non-community drinking water wells which are concentrated on the Outer Cape are generally shallower, pump less water and are often closer to septic systems. These non-community public supply wells have shown a greater degradation than the larger and deeper community wells. Since 2000, the number of non-community public supply wells with nitrate concentrations below 0.5 ppm has remained around 35%.

All of the wells exceeding the drinking water limit are located on the Outer Cape where wastewater disposal and private water supply often occur on the same lot. Assessments of private wells in Truro, Wellfleet and Eastham indicate a correlation of high nitrate concentration in relation to housing densities of less than ½ acre (Water Resources of the Outer Cape, 1998). In response to poor water quality, Wellfleet invested in a public water supply system to serve its Central downtown district and Eastham has completed water supply site investigations in two locations as a first step toward a public water system. Eastham voted overwhelming in the spring of 2014 to establish a new Town water system for critical areas of the Town. In February 2015, the Cape Cod Commission approved the town's application to permit the water supply project as a development of regional impact (DRI).

Other Considerations

EMERGING COMPOUNDS: PHARMACEUTICALS AND PERSONAL CARE PRODUCTS

Nitrate can serve as an indicator of other wastewater contaminants, such as disease-causing organisms, solvents, cleaners, petroleum compounds, pharmaceuticals and personal care products (PPCPs) and other emerging contaminants. Emerging contaminants are chemicals or microorganisms that are not commonly monitored or regulated in the environment, but are suspected of having potentially adverse ecological and/or human health effects. They can include hormones, human and veterinary pharmaceuticals, and household products like soaps and lotions, insect repellents, perfumes and other fragrances, sunscreens, and hand sanitizers.

There have been numerous national studies done to investigate and document the occurrence of these emerging compounds in wastewater, surface and groundwater. In 1999 and 2000, the USGS conducted a national stream reconnaissance testing 139 streams in 30 states for 95 organic wastewater compounds (OWCs) (Kolphin et al. 2002). Eighty-two of the 95 compounds were detected in at least one sample and 80% of the streams had at least one OWC detected. In 2000, the USGS sampled 47 groundwater sites across 18 states; 98% of the sites sampled had detections of emerging contaminants, with 46 of the 83 contaminants being found at least once (Barnes et al. 2008).

During 2001, the USGS analyzed 25 ground and 49 surface-water untreated public drinking water supply sources in 25 states. The majority of the samples (96%) showed at least one emerging contaminant. The emerging contaminants were more frequently detected in surface-water than ground-water sources (Focazio et al. 2008). Generally, all of these studies have detected the presence of a variety of organic wastewater contaminants and PPCP's. The detections were more common in the stream samples (86%) and surface water samples than in groundwater (35%). Mixtures of chemicals were common and the concentrations measured were generally at low levels (often less than 1 microgram/liter), just slightly above detection levels.

In June 2004 the USGS and the Barnstable County Department of Health and the Environment sampled wastewater sources and public, semipublic, and private drinking water supplies on Cape Cod that were thought to be affected by wastewater because of previously high nitrate concentrations. Forty-three of the 85 PPCP and organic wastewater contaminant compounds tested for were detected. Thirteen were detected in low concentrations (less than one microgram/liter) in the private and semipublic drinking water supplies and three - an antibiotic, an antidepressant and a solvent - were detected in the public water supply (Zimmerman 2005).

In May 2010 the Silent Spring Institute reported that PPCPs were detected in 75% of 22 public water supply wells sampled on Cape Cod. In general, wells with higher levels of nitrate and higher density land development in

the wellhead protection areas had a greater number of detections than those wells that were better protected by lower density and open space. In a similar study Silent Spring also found detectable traces of PPCP in fresh water ponds and private wells associated with residential development. A recent assessment by the Provincetown Center for Coastal Studies detected traces of PPCP in Nantucket Sound.

Although the ability to detect these emerging compounds at extremely low levels in drinking water has been greatly improved, the human health effects from these low level concentrations are not well documented.

In the absence of better information about the actual occurrence of these compounds and the need to provide a level of protection, MassDEP recently incorporated very stringent performance standards for proposed wastewater discharges in Zone IIs. MassDEP adopted a maximum Total Organic Carbon (TOC) Concentration of 3 ppm. TOC is a surrogate for PPCP in treated wastewater. Some studies documented that PPCP will be adsorbed on to particulates of carbon. It is thought that removing this carbon will provide a level of protection to the underlying aquifer and public supply wells. However, removing TOC to this level requires an extremely high level of treatment, with 20-30% higher capital treatment costs and higher annual operation and maintenance. Investigations into the transport of PPCP have found that the majority of these compounds do not travel very far in the groundwater. In fact, monitoring wells down gradient of existing wastewater disposal sites on Cape Cod have found concentrations of TOC below the 3 ppm concentration.

The US EPA has undertaken national testing of CECs in public water supplies, referred to as the Unregulated Contaminant Monitoring Rule (UCMR). Monitoring for selected CECs is required for water supplies serving over 10,000 connections or by voluntary action. A number of Cape Cod water suppliers have volunteered to have their supplies tested. As data becomes available through the UCMR the US EPA will be able to target more prevalent contaminants for review, research and action.

Although the Section 208 Plan Update is largely focused on the ecological impacts of nitrogen, particular attention will be focused on drinking water areas and wells that have higher levels of nitrogen as an indicator to address emerging contaminants. Additional investigation on the occurrence of emerging contaminants in groundwater will be needed to address the wastewater disposal options for any particular selected site that is located in a Zone II. In relation to the MassDEP TOC requirement to address PPCPs, substantial costs can be saved by avoiding wellhead protection areas and Zone IIs when locating potential wastewater disposal sites.

County Activities

BARNSTABLE COUNTY DEPARTMENT OF HEALTH AND THE ENVIRONMENT

MASSACHUSETTS ALTERNATIVE SEPTIC SYSTEM TEST CENTER

The Massachusetts Alternative Septic System Test Center has been operating since 2000 to research and test advanced on-site wastewater treatment systems. The Center is operated by the Barnstable County Department of Health and the Environment (BCDHE) and is located at Joint Base Cape Cod. Although the Center's initial emphasis was on nutrient-reducing technologies, it has more recently been conducting research on the efficacy of commercial and soils-based septic systems for removal of pharmaceuticals and personal care products. The Center has been instrumental in forming and conducting many internationally recognized standards for both secondary and tertiary wastewater treatment. Ancillary projects include the support of research efforts on wastewater diversion techniques, such as composting toilets and urine diversion, and their efficacy for addressing the nutrient management issues in sensitive watersheds.

The majority of the systems tested at the Center are proprietary systems and the efficacies of non-proprietary denitrification strategies are less understood, primarily due to the lack of financial incentives to develop and promote them. It is clear, however, that Cape Cod communities are interested in exploring all of the options available for

reducing nitrogen that enters the groundwater. Through this process to update the Section 208 Plan for Cape Cod, funding was provided to the County Department of Health and the Environment to investigate non-proprietary means to remove nitrogen by enhancing and/or manipulating soils-based systems. This work is essential in order to assure wastewater planners, managers and the public that all options are properly evaluated. More information on the study and progress to date is available in Appendix 2B.

INNOVATIVE/ALTERNATIVE SEPTIC SYSTEMS PERFORMANCE TRACKING

More than 1,500 innovative/alternative (I/A) septic systems have been installed on Cape Cod in an attempt to reduce the amount of nitrogen discharged into the groundwater. These systems range in their complexity, but all require regular maintenance and monitoring. Since 1999, BCDHE has maintained a database to assist regulators in the task of tracking performance and adherence to maintenance schedules. Regular performance and compliance updates are provided to local regulatory boards. More recently, to aid the public and engineering professionals, the department has created an interactive tool to chart performance of all technologies used within Barnstable County. This tool assists wastewater planners to develop realistic performance expectations, thus facilitating accurate local wastewater planning. Occasionally, printed compendia of the information are distributed to local boards and commissions. The department also maintains training tools to instruct boards of health regarding the proper application of these technologies.

COMMUNITY SEPTIC MANAGEMENT LOAN PROGRAM

The Barnstable County Department of Health and the Environment initiated the Community Septic Management Loan Program to assist homeowners by defraying the costs of septic system upgrades through provision of 20-year betterments. More recently the program has assisted in providing support for the actual connection costs to centralized systems or combined packaged or cluster treatment systems. For more information visit the Community Septic Management Loan Program website at http://www.barnstablecountysepticloan.org/.

CAPE COD COMMISSION

TECHNICAL SERVICES

As the region's planning agency, the Cape Cod Commission supports its regulatory and planning mission with the provision of technical services by professional staff in almost every issue area of the Regional Policy Plan (RPP) for various county, local, state and federal agencies, associations and citizens. In the area of water resources, the Commission staff provides support on water supply, freshwater ponds, coastal water quality, wastewater management and groundwater cleanup. Staff members develop both quantitative and qualitative methods that result in finding cost-effective solutions for common problems shared across the region. Staff members have provided fundamental expertise in the development of local and regional wastewater management planning and in the development of the tools and resources developed as part of the Section 208 Plan Update.

Town Wastewater Planning Efforts

All 15 Cape Cod towns have engaged to some degree in the process of developing Comprehensive Wastewater Management Plans (CWMPs) over the last 10 years. Several towns are in the Massachusetts Environmental Policy Act (MEPA) review process. A Cape Cod Commission regulatory review file of comments letters, public hearings and decision documents are available for each town that is undergoing the MEPA/DRI review process for their CWMP. Barnstable, Chatham, Falmouth and Provincetown have existing wastewater infrastructure and have completed wastewater facilities plans prior to or in conjunction with nutrient planning. The following is a synopsis of the CWMP planning efforts in each town.

STATUS OF CWMPS

BARNSTABLE

The town of Barnstable is working on a town-wide nutrient management plan that will provide the basis of its CWMP. The town completed the MEPA/DRI review process for what is known as the Wastewater Facility Plan (WWFP) in 2007. This included upgrades and expansion of the Hyannis Water Pollution Control Facility (WPCF). The WWFP resolved

wastewater disposal issues relative to wastewater disposal site capacity and identified nine Areas of Concern (AOCs) for sewer hook-up. The DRI approval conditions require an adaptive management plan for monitoring the wastewater facility as it approaches a discharge rate of 3.7 million gallons per day (MGD), prior to attaining its design capacity of 4.2 MGD. The additional 0.5 MGD may require the use of an approved remote disposal site known as the Route 132 site. The DRI conditions also include the scope for the nutrient management plan and provisions for continuing sewer expansion under the WWFP.

The town implemented the upgrades to its present facility and completed a sewer extension project for the Stewart's Creek area in the village of Hyannis.

The town reformulated a Citizen's Advisory Committee (CAC) for wastewater planning and has been working on the nutrient management plan/CWMP. The Alternatives Screening Analysis of the CWMP was submitted as a Draft Environmental Impact Report (DEIR)/Environmental Notification Form (ENF) for joint MEPA/DRI review in May 2012. The Needs Assessment and Alternatives Screening Analysis conclude with five alternative plans, not including the no-action alternative. Each alternative assumes a portion of the town will remain on Title 5 systems, where nutrient removal is not critical, and that remote recharge sites for treated effluent will be needed. The alternatives include a totally decentralized solution; a decentralized solution with some larger facilities; and centralized alternatives with either a single town plant or multiple town plants. Since the Hyannis WPCF is located in a zone of contribution to public water supply (Zone II) and would require expensive total organic carbon (TOC) removal options, the CWMP also includes ocean outfall as an alternative, as well as the alternative of abandoning existing public water supply wells.

The MEPA certificate scope for the Final Environmental Impact Report (FEIR) includes extensive comments and significant additional work. One component of the MEPA certificate is to engage in a targeted watershed approach. The Commission is presently working with Barnstable and Yarmouth to develop a targeted-watershed scope for the Lewis Bay watershed. The Commission and the town have discussed the use of the WatershedMVP to evaluate targeted watershed approaches for Three Bays. The CAC is presently considering the next appropriate steps.

A more detailed chronology of water quality planning efforts in Barnstable is available in Appendix 2C.

BOURNE

The town of Bourne recently completed a targeted wastewater planning effort for the Buzzards Bay downtown area. A portion of the Buzzards Bay area is sewered and up to 200,000 gpd of wastewater is conveyed to Wareham for treatment and disposal. Bourne is limited to this flow through its agreement with the town of Wareham.

The Cape Cod Commission worked with the town of Bourne to develop a wastewater and water supply report for Buzzards Bay. The report provided the town with a detailed assessment of the needs, alternatives, facility siting options, and estimated costs of providing wastewater infrastructure to support the revitalization of the Buzzards Bay area. A copy of the report is available on the Commission's Initiatives webpage. The town voted to approve the report's recommendations to obtain in-house expertise to guide the project and to conduct necessary steps for siting and infrastructure evaluations. In March 2013 the town hired a wastewater coordinator and soon after hired a contractor to determine if either of two identified sites - Queen Sewell Park and land behind the Bourne Veterans Memorial Community Center - is suitable for wastewater disposal. The Queen Sewell Park site was determined to be a suitable site to consider moving forward.

The town of Bourne received a MEP technical report for Phinneys Harbor/Eel Pond and Back River, but reports for other watersheds within its boundaries, including Megansett, Sequeteague, Pocasset, and Buttermilk Bay are not complete or not planned, making it difficult to pursue meaningful wastewater assessments in these areas.

A more detailed chronology of water quality planning efforts in Bourne is available in Appendix 2D.

BREWSTER

In 2009, the Town of Brewster formed a Comprehensive Water Planning Committee (CWPC). The CWPC is charged with coordinating the efforts of the Town staff and consultants and it began the CWMP process in 2009. The town chose to pursue an Integrated Water Resources

Management Plan (IRWMP) because it wanted to closely evaluate drinking water and freshwater pond issues in addition to coastal water quality impairments.

Phase I of the IRWMP was completed in 2011. As a result the town initiated a number of intermediate projects to expand the Town's data and understanding of water quality. In January 2013, Phase II of the IRWMP was issued. The report recommends a number of alternatives for coastal nitrogen reduction in the Pleasant Bay watershed, including innovative/alternative (I/A) and cluster systems, fertilizer reduction, irrigation wells to recycle and reduce groundwater concentrations, permeable reactive-barrier technologies, and alternative toilets (see Chapter 4 for technology descriptions).

The town is continuing its efforts toward drinking water protection through its bylaws and the Brewster Water Protection District of Critical Planning Concern. A number of specific opportunities for stormwater treatment have been identified and conceptual designs have been developed. There are a number of freshwater pond protection strategies that are also recommended.

The town secured funding for Phase III of the IRWMP and began work in June 2013. The goals of Phase III are to:

- Evaluate the Pleasant Bay nitrogen management alternatives identified in the Phase II report and select a preferred plan with recommendations for what Brewster needs to do to restore water quality within Pleasant Bay;
- Finalize recommended stormwater regulations developed in Phase II;
- Encourage proper management of stormwater, septic systems, fertilizers and other potential pollutants that impact Brewster's Ponds (e.g., new regulations);
- Continue with current outreach activities (e.g., website, brochure);
- Facilitate communication between the CWPC, the Cape Cod Commission, the public, and with other town boards and agencies involved in the project.

A more detailed chronology of water quality planning efforts in Brewster is available in Appendix 2E.

CHATHAM

The Chatham CWMP of 2009 is the first town-wide plan on Cape Cod to be completed that incorporates the state and federal total maximum daily loads (TMDLs) to restore coastal water quality for several large coastal embayments. The CWMP/FEIR provides a strategy for wastewater management and reduction of nitrogen loading to restore and protect Chatham's marine embayments, addresses other areas of concern, such as areas experiencing high groundwater, failing systems, and industrial/commercial areas, and includes an adaptive management plan for its implementation.

The prior WPCF in town was built in 1970 and the collection system extended to the Main Street downtown area. Prior to development and implementation of the CWMP this facility served approximately 480 properties.

The CWMP/FEIR details a two-phased implementation program to meet nitrogen TMDLs in Stage Harbor, Pleasant Bay, Sulphur Springs, and Taylors Pond. Phase 1 average annual wastewater flows are projected to be 0.94 MGD. The Phase 2 wastewater flows will be 38 percent more than Phase 1, for an average annual flow of 1.3 MGD over 30 years. The extension of sewers to the remaining part of town will take another 10 years, with an estimated completion date of 2040.

The estimated Phase 1 costs are $210 million (in 2007 dollars) over the initial 20 years. The town has adopted a number of innovative approaches for funding the project and has established a capital facilities plan with the goal of maintaining the tax rate. However, it is acknowledged that modest tax increases will be necessary to meet the costs of the proposed plan. Homeowner charges are estimated at $3,000 to $10,000 for hook-up and $400 for annual operation and maintenance.

The state and the Cape Cod Commission reviewed this 11-year project as a DEIR in 2008 and as a FEIR in 2009. An expanded adaptive management plan scope was part of the conditions of the DRI approval, which included components of implementation progress, Groundwater Discharge Permit monitoring, and monitoring of marine waters for TMDL compliance. The final adaptive management plan was submitted to the Commission two years after the DRI approval.

The town completed the treatment facility upgrade in 2010 and the main sewer trunk line construction in 2012 and is seeking State Revolving Fund (SRF) funding for the next

stage of sewer expansion in to the Stage Harbor watershed system - an area impaired by nitrogen. In 2013 the town signed an agreement with the town of Harwich to further evaluate using a portion of the treatment capacity in Chatham to serve the eastern portion of Harwich, which is part of the shared Pleasant Bay watershed. The potential sharing of the facility is allowed by condition in the DRI approval. Chatham has also been a lead town in the effort to improve circulation in Muddy Creek with a culvert-widening project that would likely reduce nitrogen removal requirements.

A more detailed chronology of water quality planning efforts in Chatham is available in Appendix 2F.

DENNIS

The town of Dennis received MEP technical reports for Herring River, Swan Pond and Bass River. Working through the Dennis Water District, the town completed fundamental portions of a needs assessment that identified a number of areas to be addressed for both nutrients and Title 5 constraints on economic redevelopment in the area of Dennisport. The district filed and passed legislation to become the Dennis Water and Sewer District. The November 2013 special Town Meeting voted to approve funding for a consultant to study previously collected data, identify problems, and recommend possible solutions, along with their costs. The output will be a water quality evaluation and mitigation alternative study for the district and the town to consider as they plan their next appropriate steps for wastewater planning.

A more detailed chronology of water quality planning efforts in Dennis is available in Appendix 2G.

EASTHAM

The town of Eastham completed a town-wide needs assessment in March 2009. The needs assessment concluded that a new public water supply system to protect public health was an overriding concern. In 2013, Town Meeting did not approve the expenditure of funds for either a town-wide water system, at a cost of about $114 million, or a phase 1 water system, at a cost of about $41 million, to serve those areas with the greatest need.

The spring 2014 Town Meeting approved $45.8 million to fund a scaled back version of the full town-wide water system. The system is described as a “backbone with landfill study area service,” which will include all the basic elements to allow for expansion to all parts of the town in the future. This backbone will include a single water tower, two wells, with service connecting along major roadways and to the affected areas within the landfill study area. It includes hydrants that will be within 1000 feet of 80% of Eastham structures. The Cape Cod Commission approved this project as a DRI in February 2015.

In addition to pursuing solutions for water supply protection, the town of Eastham is actively pursuing the protection and restoration of its freshwater ponds. The town completed a town-wide assessment and is pursuing in-pond restoration efforts. Alum treatments for Herring Pond and Great Pond are complete and others are under consideration.

Eastham shares the watershed to the Nauset estuary with the town of Orleans and is willing to have further discussions about potential opportunities to share the wastewater treatment facility proposed in the approved Orleans CWMP.

A more detailed chronology of water quality planning efforts in Eastham is available in Appendix 2H.

FALMOUTH

The town of Falmouth completed the MEPA/DRI process for the West Falmouth Harbor WWFP in 2001. The WWFP focused on a necessary upgrade to the existing treatment facility in order to achieve better nutrient-removal rates. The sensitivity of West Falmouth Harbor to nitrogen loading was not well understood when the facility was permitted in the 1980s. The upgrade is now complete and water quality conditions within the groundwater have improved significantly. However, the disposal location has a limited capacity due to sensitivity of the estuary to additional nitrogen inputs.

The Cape Cod Commission reviewed an ENF for the Town of Falmouth Comprehensive Wastewater Management Planning Project for the South Coastal Watersheds in 2007. The ENF included the Needs Assessment Report and Alternatives Screening Report for Little Pond, Great Pond, Green Pond, Bournes Pond, Eel Pond, and Waquoit Bay. This draft CWMP included collection of wastewater in the south coastal areas, generally south of Route 28, treatment at a proposed regionally-shared facility at Joint Base Cape Cod (MMR at the time), and effluent disposal through

injection wells. The town formulated a new internal review committee, the Water Quality Management Committee (WQMC), to evaluate additional alternatives, and in 2012 submitted a draft CWMP/DEIR for joint MEPA/DRI review.

The 2012 draft CWMP/DEIR represented a significant change from the screened alternatives presented in the 2007 ENF. In addition to plans for sewering specific portions of the south coastal estuaries and upgrading the West Falmouth treatment facility and discharge options, the DEIR included specific opportunities for innovative on-site technologies and non-discharging systems, tidal flushing, aquaculture, permeable reactive barrier demonstration projects, and non-structural nitrogen reduction strategies consisting of fertilizer controls and stormwater management.

Through its review, the Commission supported the additional evaluation of Joint Base Cape Cod as a potential shared regional facility for the Upper Cape as one the town's alternatives.

The town received wastewater grant funds from Barnstable County for:

- technical assistance from the USGS and Cape Cod Commission staff to use a groundwater model to evaluate potential wastewater disposal sites;
- detailed hydrogeologic modeling of a likely discharge site, the Falmouth Country Club; and,
- technical assistance through the Cape Cod Water Protection Collaborative.

The town implemented the recommendations of the WQMC and Town Meeting approved $2.77 million to retain an omnibus engineering consultant to oversee design aspects of the entire project and separate expert consulting capacity to prepare feasibility studies for the pilot projects. Spring 2013 Town Meeting appropriated $9 million to provide the design of the Little Pond watershed collection system, necessary facility upgrades, and pilot project implementation.

In January 2014, a MEPA Certificate of Adequacy was issued for the Falmouth South Coast Watersheds CWMP. The certificate details how projects included in the CWMP will come forward as Notices of Project Change in the future. The Commission approved the CWMP as a DRI in February 2014 with conditions to develop an adaptive management plan.

Spring 2014 Town Meeting subsequently approved $50 million to construct a targeted watershed approach for a Little Pond watershed collection system and implement the pilot projects over the next five years, concluding in 2020.

A more detailed chronology of water quality planning efforts in Falmouth is available in Appendix 2I.

HARWICH

The town of Harwich established a water quality management task force to coordinate both fresh and marine water sampling. The task force is responsible for wastewater planning, which consists of developing a CWMP and participating in the Pleasant Bay Alliance.

The Harwich efforts were on hiatus while waiting for the Massachusetts Estuaries Project (MEP) to complete the technical reports for Herring River and several of the south-side embayments. These reports were received by the town in 2010-2012.

The town has since submitted an expanded ENF and anticipates participating in joint MEPA/DRI review with the Cape Cod Commission.

The CWMP includes options for regional infrastructure with the town of Chatham for the East Harwich economic development area of town (part of the shared Pleasant Bay watershed). The town recently signed an agreement with the town of Chatham to evaluate this option.

Harwich is also the lead town in a shared effort to improve circulation in Muddy Creek with a culvert-widening project that will likely reduce nitrogen removal requirements. Design of the culvert is close to complete and construction was scheduled to begin in fall 2015. The project received two federal grants - $3.4 million of Hurricane Sandy Mitigation and Resiliency funding and a $1 million National Coastal Wetlands Conservation grant - and spring 2014 Town Meeting approved the appropriation of an additional $1.75 million.

A more detailed chronology of water quality planning efforts in Harwich is available in Appendix 2J.

MASHPEE

The Mashpee CWMP was scoped through a joint MEPA/DRI review as an ENF in 2001. In 2007, the town submitted its Needs Assessment Report entitled, "Town of Mashpee, Popponesset Bay and Waquoit Bay-East Watersheds Needs Assessment Report." The report documents the significant level of effort that has gone into determining the nitrogen TMDLs for the two subject embayments over the course of six years. Also in 2007, the town completed a technology screening report, which was followed shortly by its draft alternative scenarios and site evaluation report in March 2008.

Mashpee has been engaged in numerous county, state, and federally funded projects, including the 2009 MassDEP Pilot Project and the 2009 Cape Cod Commission TMDL Implementation Project, which were both funded by US EPA. Through these projects, the town ran a number of scenarios through the MEP linked water quality model to evaluate TMDL compliance strategies, including an assessment of cranberry bogs and streams for potential additional natural attenuation. These projects also allowed Mashpee, together with representatives of Barnstable and Sandwich, to participate in the determination of nitrogen allocation for Popponesset Bay for each town and prepare a draft intermunicipal agreement. Mashpee received wastewater grant funds from Barnstable County to model sewer collection systems in the Popponesset watershed and technical assistance from the USGS and Commission staff to use the Sagamore Lens groundwater model to evaluate potential wastewater disposal sites.

The Needs Assessment contains a characterization of the nine operating private sewage treatment facilities, including treatment efficiency and excess capacity. This work allowed the town to focus on three potential wastewater scenarios that were developed in 2012. These options are being reviewed and will be the basis for development of their preferred alternative. The wastewater scenarios include use of the existing private plants at their planned capacity and either three or four subregional plants with consideration of shared town responsibility. Off-site disposal of effluent outside of the impaired watersheds is an important consideration for the plan's approach. The alternatives analysis included consideration of private effluent disposal sites at New Seabury, Willowbend, and others, in addition to the town's transfer facility site.

The town has an appointed seven-member Sewer Commission and an in-house coordinator for wastewater projects as the town proceeds with selecting a preferred alternative. Special legislation filed by the town to convert the Mashpee Water District to the Mashpee Water and Sewer District was signed by the Governor on April 18, 2014 and is pending approval by Mashpee voters. In addition to the needs and alternatives identified, the town is considering the use of the JBCC treatment facility and disposal site as long-term regional solutions.

In April 2014, the Sewer Commission met with Cape Cod Commission staff to begin the discussion around filing its CWMP. The current draft plan includes a significant aquaculture undertaking and an adaptive management approach to achieving water quality goals. In September 2014, the Massachusetts Secretary of Energy and Environmental Affair issued a certificate of adequacy for the DEIR for Mashpee's Comprehensive Watershed Nitrogen Management Plan.

A more detailed chronology of water quality planning efforts in Mashpee is available in Appendix 2K.

ORLEANS

The Orleans CWMP was approved by MEPA and the Cape Cod Commission in 2011 and provides a strategy for wastewater management to achieve reductions of its share of nitrogen loading to restore and protect Orleans's coastal embayments. The CWMP also addresses freshwater ponds and areas with septic system problems associated with frequent pumping, intensity of use and mounded systems. It provides modest capacity for expanded residential housing in the commercial district and includes an adaptive management approach for its implementation.

The CWMP proposes collection of an annual wastewater flow of 0.64 MGD from 2,800 properties to serve 53% of the town. The project would be implemented in six phases over a 15-20 year period of implementation.

The phased sewer plan also accommodates septage and sludge handling and proposes five small package-treatment systems that will hasten nutrient removal for subwatersheds to Pleasant Bay as the plan is phased in. The phased plan also targets nutrient reduction through non-structural elements, including a fertilizer control program, stormwater management, a water conservation

program coupled with a wastewater flow- and load-reduction initiative, enhancement of embayment flushing, and land use controls.

The estimated cost of the CWMP is $150 million (in 2008 dollars) over the 15-20 year implementation period. The average cost to a homeowner is estimated at $2,600 per year. The town has adopted a cost-recovery policy that incorporates property tax assessment to pay for 80% of the costs and relies on betterments for the remaining 20%.

The town asked the Cape Cod Commission staff to participate in reviewing the needs assessment, alternatives assessment, and preferred alternative reports prior to their formal submittal as a DEIR/ENF in 2009. As part of its CWMP process, Orleans took advantage of a Cape Cod Water Protection Collaborative grant to examine potential cost savings that could be realized if the planned Orleans wastewater facility were shared with the towns of Brewster and/or Eastham. The resulting study, entitled "Wastewater Regionalization Study: Orleans-Brewster-Eastham," was released in December 2009. The study identified a potential 6-9% savings in capital costs, and an 18-25% savings in operation and maintenance (O&M) costs resulting from a shared facility.

The town received its MEPA certificate on the FEIR and a DRI approval in 2011. The town has since engaged independent consultants to review the use of alternative sewer collection technologies and the Massachusetts Estuaries Project findings about the Nauset Marsh. The town received significant input from the community as the board of selectmen considers its appropriate next steps.

The Orleans CWMP DRI approval contained several conditions related to the potential of operating the Orleans facility as a shared municipal facility. The Town of Orleans agreed to meet with Brewster and Eastham representatives to discuss potential regionalization options and report to the Commission on the status of those discussions. The DRI decision also directs the Town of Orleans to keep options open for sharing the proposed facility, as well as disposal capacity at the facility, for a finite period of time. The intent of this condition was to create an opportunity for the three towns to pursue a shared facility, while allowing Orleans to proceed with its single town plan in a reasonable time frame.

Another regional issue raised by the Orleans CWMP is that the proposed Orleans wastewater facility will discharge into the Nauset Marsh system, which has assimilative capacity for nitrogen. The Town of Brewster expressed concern about the potential for Orleans to use up this assimilative capacity, leaving Brewster with fewer disposal alternatives as it develops its own management plan. The DRI decision capped the amount of assimilative capacity that may be used by Orleans in order to address this concern.

Funds for design and construction of the Orleans CWMP, or phases within the CWMP, have not yet been appropriated by Town Meeting.

Spring 2014 Town Meeting approved an extension of the three-town agreement with Eastham and Brewster through 2016 to run the Tri-Town Septage Treatment Facility. Town Meeting also approved an appropriation of $1.045 million to fund several projects with a collective purpose to produce information necessary to further shape water quality improvement projects in town. Specifically, the appropriated funds will be used for engineering, planning and hydrogeologic studies necessary for the development of septage, wastewater, groundwater and stormwater management plans needed to maintain and protect the water resources of the town by integrating the CWMP with a new Adaptive Management Plan and components of the Cape-wide Section 208 Water Quality Management Plan.

A more detailed chronology of water quality planning efforts in Orleans is available in Appendix 2L.

PROVINCETOWN

Provincetown completed a WWFP in 2001. The plan dealt with the public health issues of failing septic systems and inadequate infrastructure for its commercial downtown area. The comprehensive plan was approved by state agencies through MEPA and by the Cape Cod Commission through DRI review in 2001. The wastewater facility and phase 1 and 2 areas were subsequently built and are performing well. The plan included a number of innovative aspects, including a lot-by-lot assessment of Title 5 systems, use of the Route 6 median and right-of-way for effluent disposal, combination of force mains, conventional gravity and vacuum sewers, and "checkerboard" sewer areas. The plan included three phases. The town is presently expanding sewers into the Phase 3 area and is upgrading the facility to its planned capacity. During this implementation, the town was able to use measured

wastewater flow to compare to the design capacity and to negotiate the use of that excess capacity for new wastewater flow.

A more detailed chronology of water quality planning efforts in Provincetown is available in Appendix 2M.

SANDWICH

The town of Sandwich has established a water quality committee to oversee water quality and wastewater planning efforts. The committee developed a scope of work for a CWMP and submitted the scope under the Sagamore Lens Natural Resource Damages Assessment, related to past groundwater contamination at the Textron facility at the Joint Base Cape Cod (JBCC). The town received an award of $400,000 t0 conduct its water/wastewater plan and completed a comprehensive needs assessment, as well as an interim wastewater solutions plan to accommodate economic development in the South Sandwich Village Center (often referred to as the Golden Triangle area).

The town spent several years working with a private developer on a development project that included a public-private wastewater component involving the construction of a facility that would accommodate the private project and a certain amount of general public wastewater need. That project will not be completed, but the town is again seeking a private partner to create new economic growth and to potentially participate in infrastructure development.

The town is participating in discussions at JBCC about the potential use of its existing wastewater infrastructure as a regional option for the Upper Cape towns.

A more detailed chronology of water quality planning efforts in Sandwich is available in Appendix 2N.

TRURO

The town of Truro approved funds for a CWMP, acknowledging that protection of private-well drinking water is of paramount importance, and established a water resources oversight committee. The CWMP kicked off in 2012 with a focus on septic systems and stormwater-runoff and their impact on drinking water and embayment water quality. The planning process seeks to assemble existing data, and develop a GIS program to evaluate land and water data, historic septic-system management information and key areas for further analysis and characterization. The committee is in the process of reviewing the phase 1 of the draft water management plan.

A more detailed chronology of water quality planning efforts in Truro is available in Appendix 2O.

WELLFLEET

The town of Wellfleet has an established Comprehensive Wastewater Management Planning Committee that is charged with providing a comprehensive strategy for addressing wastewater treatment and disposal issues for the next 40 years and for the foreseeable build out conditions in town. Along with its consultant, the town completed a draft of its CMWP Needs Assessment and Alternatives Analysis reports in June 2012. The objectives of the CWMP are to protect and enhance the Wellfleet Harbor ecosystem, promote aquaculture-based water quality management solutions, identify low-cost and sustainable remedies, develop least-cost alternatives and, only as a final resort, engage in structured solutions.

The CWMP process allowed Wellfleet to pursue and implement pilot scale ecotoilet and oyster restoration solutions (see Chapter 4 for technology descriptions). Spring 2013 Town Meeting appropriated funds to build a bathhouse at Bakers Field Beach that uses composting toilet technology to reduce the nitrogen load to Wellfleet Harbor. The oyster restoration project is a 2-acre site in Wellfleet Harbor and has a well-structured monitoring component. Water quality monitoring was conducted at the site in 2012 and 2013 and provided necessary data for the town to make informed decisions moving forward.

A more detailed chronology of water quality planning efforts in Wellfleet is available in Appendix 2P.

YARMOUTH

The town of Yarmouth's wastewater committee began its work in 2003. In 2010, the town submitted its CWMP as a DEIR. The draft CWMP targeted areas that would require wastewater collection to restore water quality in the Lewis Bay and Parkers River watershed and deal with the Title 5 constraints on economic redevelopment in the area of Route 28. The town's plan included approximately 125 miles of sewer lines and the collection of 2.75 MGD of wastewater to

be treated at a single facility in the Parkers River watershed. The project would ultimately serve 9,580 properties by 2035. Phase 1 of the plan would begin with the treatment facility and main trunk line sewer to serve Route 28 and portions of the Parkers River and Lewis Bay watershed.

The town submitted its FEIR and received MEPA approval in July 2011, but did not complete the DRI process before going to September 2011 Town Meeting to seek Phase 1 design and construction funds. Phases 1 through 5 were scheduled to be implemented over a 25-year period. The estimated cost of the total plan was $275 million. The first phase had an estimated cost of $55 million. Town Meeting did not approve the expenditure. The town withdrew the CWMP from the DRI review process and is evaluating the next appropriate steps.

Yarmouth officials have been meeting with Cape Cod Commission staff, MassDEP and Barnstable officials to discuss the scoping of a targeted watershed approach for Lewis Bay.

A more detailed chronology of water quality planning efforts in Yarmouth is available in Appendix 2Q.

Existing Wastewater Infrastructure

There are four communities with municipally owned and operated wastewater treatment facilities on Cape Cod. In addition, there are a number of small and privately owned and operated facilities located throughout the region.

What follows is a brief summary of the existing municipal infrastructure, including information on current treatment and disposal capacity. Future analysis of potential expansion capacity of the existing municipal facilities may benefit Cape Cod communities looking for affordable solutions to collect and treat wastewater. The existing infrastructure located in and serving Joint Base Cape Cod is discussed in Chapter 7.

The four communities currently operating municipal wastewater treatment facilities are Barnstable, Chatham, Falmouth and Provincetown.

BARNSTABLE

The Hyannis WPCF, located off Bearses Way in Hyannis, is the primary facility serving the town. It has a permitted capacity of 4.2 MGD that is discharged on-site through open sand beds. In addition to the on-site discharge capacity, the town of Barnstable acquired the “McManus” site on Route 132 in 2002 to potentially accommodate future flows; however, this site is not being used today.

Current operating conditions at the facility treat an average daily flow of 1.46 MGD and a maximum monthly average flow of 1.94 MGD. Treatment performance has averaged 5 milligrams per liter (mg/L) total nitrogen in the treated effluence and the facility has a discharge limit of 10 mg/L. The facility is also equipped with sludge thickening, storage and dewatering facilities sized for the current process conditions.

The town of Barnstable also operates two smaller facilities - the Marstons Mills Wastewater Treatment Facility (WWTF) and the Red Lily Pond Cluster System. The Marstons Mills WWTF is limited to a discharge flow of 42,900 GPD and is intended to service the Barnstable United Elementary School and the Village at Marstons Mills affordable housing development. The Red Lily Pond Cluster System currently serves 17 homes.

CHATHAM

The Chatham WWTF, located on an 80-acre parcel on Sam Ryder Road, recently underwent a major upgrade as part of phase 1 CWMP. The facility has a permitted capacity of 1.0 MGD (annual average) and 2.3 MGD (peak day) and two existing sand beds, which have been in operation for 35 years. The permit requires a discharge limit of 10 mg/L with an annual limit of 9.132 pounds/year, which corresponds to an annual average discharge of 3 mg/L.

The upgrade to the WWTF included several improvements to its sludge processing capabilities. Dewatered sludge is discharged and taken off site for disposal. The site also accepts septage collected from Chatham parcels only.

FALMOUTH

The Falmouth WWTF, located on Blacksmith Shop Road, was upgraded from a lagoon treatment process to include Sequencing Batch Reactors (SBR) and denitrification filters in 2005. The facility is currently permitted with an effluent flow restriction of 0.8 MGD. The permit limits flows to the WWTF to 0.23 MGD inside the West Falmouth Harbor watershed and 0.57 MGD outside the West Falmouth Harbor watershed. On January 10, 2014 the town received a Certificate of Adequacy from the Secretary Of Energy and Environmental Affairs to sewer the Little Pond Service Area and discharge up to 260,000 GPD at a new disposal site is being pursued ("Site 7"), north of the existing beds and outside the West Falmouth Harbor watershed. The town is moving forward with a new effluent measuring system and optimization and improvement to the existing treatment system including the sludge thickening process at the facility.

PROVINCETOWN

The Provincetown WWTF is an advanced secondary treatment plant that is capable of treating a maximum daily flow (MDF) of 650,000 GPD, with discharge to four subsurface disposal beds at six locations along Route 6. Additional upgrades may be required to increase the capacity to allow a MDF of 750,000 in the future, and will occur when required.

Provincetown is currently working to design, permit, expand, and operate its wastewater collection, treatment and disposal systems.

The current sludge management plan includes periodic removal from the SBRs, storage for aeration and mixing, and hauling by a contractor for disposal at a facility in Cranston, RI.

03 POLICY

Regulations

Advancements in the sciences of marine ecosystems and hydrogeology have helped improve understanding of ongoing impairments as well as establish new standards for coastal water quality, but the language and enforcement tools contained in important water quality statutes are imperfect solutions to today's problems.

The Clean Water Act was effective in stopping direct discharge water pollution and Massachusetts Title 5 regulations successfully protect public drinking water supplies from septic system pollution, but neither is well suited to address coastal nutrient pollution on Cape Cod. The Clean Water Act, as applied, does not regulate discharges on Cape Cod and Title 5 allows septic systems with nitrogen levels in effluent that degrades water quality in embayments.

REGULATORY STREAMLINING

The current permitting and regulation framework is a one-size fits all approach with little consideration for shared watershed permitting and regulation across municipal lines. What's recommended provides a necessary evolution of this framework to successfully implement established federal and state water quality goals.

TARGETED

A permitting approach that allows Targeted Wastewater Management Plans reduces upfront planning time, lowers cost and focuses attention where it's needed.

REDUCTION CREDITS

Towns should get credit for what they are already doing. Policies to reduce fertilizer use and stormwater runoff, supported by performance monitoring, should lower watershed nitrogen reduction targets.

WATERSHED PERMIT

Under the watershed permit approach, nitrogen loads are allocated on a watershed-by-watershed basis, as developed through the Waste Treatment Management Agency, or WMA, designations. The watershed permit will list all technology options identified for implementation by stakeholders for the particular watershed, as well as each permittee's specified annual discharge limit.

Regulating the Problem v. Regulating the Solution

Septic systems are the primary wastewater management infrastructure tool on Cape Cod, with limited groundwater discharges from four (Barnstable, Chatham, Falmouth, and Provincetown) publicly owned treatment works (POTWs) and 58 of smaller wastewater treatment works. These discharges are managed by a one size fits all approach with little consideration for shared watershed permitting and regulation across municipal lines. Wastewater management plans with traditional technologies have clear but often lengthy and extensive permitting paths while alternative technologies are often not permitted or their nitrogen reduction performance is poorly understood and not applied to meeting overall watershed nitrogen management goals and standards.

An inescapable conclusion of the Section 208 Plan Update is that the current regulatory scheme is ill suited to result in effective solutions to the water quality challenges of Cape Cod and that reform is necessary for effective and affordable outcomes to be realized. The recommendations

History of the Clean Water Act

The Federal Water Pollution Control Act of 1948 was the first major U.S. law to address water pollution. Growing public awareness and concern for controlling water pollution led to sweeping amendments in 1972, when the law became commonly known as the Clean Water Act.

The 1972 Amendments:

- Established the basic structure for regulating pollutants discharges into the waters of the United States.
- Gave US EPA the authority to implement pollution control programs such as setting wastewater standards for industry.
- Maintained existing requirements to set water quality standards for all contaminants in surface waters.
- Made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions.
- Funded the construction of sewage treatment plants under the construction grants program.
- Recognized the need for planning to address the critical problems posed by nonpoint source pollution.

Subsequent amendments modified some of the earlier provisions. Changes in 1987 phased out the construction grants program, replacing it with the State Water Pollution Control Revolving Fund, more commonly known as the Clean Water State Revolving Fund.

For more information: www2.epa.gov/laws-regulations/history-clean-water-act

3

that follow suggest a necessary evolution of the tools and established regulatory framework to successfully implement federal and state water quality goals to protect and restore coastal waters, while providing flexibility and certainty in the permitting path for local decision makers.

Regulating the Problem: Existing Regulation and Permitting

FEDERAL REQUIREMENTS AND GOALS

FEDERAL CLEAN WATER ACT

The United States Environmental Protection Agency (US EPA) regulates water quality under the federal Water Pollution Control Act of 1972 and its subsequent amendments in 1977, 1981, and 1987. Collectively these are known as the Clean Water Act (CWA) (see http://www.epw.senate.gov/water.pdf for the full Clean Water Act). The objective of the act is to maintain and restore the chemical, physical and biological integrity of US waters. The act requires states to establish ambient water quality standards for water bodies based on the need to protect the use(s) designated for that water body.

The CWA provides the umbrella for the planning, permitting and financing of water pollution control facilities nationally. As a national tool, it deals in broad strokes with the causes of water quality impairment as they were understood at the time of passage and subsequent amendment of the Act. The law has not been updated to address the diffuse and nonpoint nature of water quality problems experienced on the Cape in mind and, as a result, is an imperfect tool for devising and implementing solutions scaled to Cape Cod.

Clean Water Act Section 208

A cornerstone, but rarely still utilized portion of the CWA is Section 208. This section provides the template for areawide waste treatment management plans, like this one, that form the blueprint for attainment of water quality goals within a given region. Plans prepared pursuant to Section 208 of the Clean Water Act must include, in pertinent part, identification of treatment works necessary to meet anticipated waste treatment needs of the area over a 20-year period; establishment of construction priorities and time schedules for the treatment works; establishment of a regulatory program; identification of those agencies necessary to construct, operate and maintain all facilities required by the plan; identification of measures necessary to carry out the plan, including financing and the economic, social, and environmental impact of carrying out the plan; a process to identify construction activity related sources of pollution and to set forth procedures to control such sources; a process to control the disposition of all residual waste that could affect water quality; and a process to control the disposal of pollutants within such area to protect ground and surface water quality.

Section 208 also requires states, as part of the certification process, to designate one or more Waste Treatment Management Agencies (WMAs). WMAs have specific responsibilities articulated in the CWA, including the ability to build and operate treatment works and technologies outlined in their watershed plan to achieve Total Maximum Daily Load (TMDL) compliance, but also issue bonds and notes to raise revenues to carry out their plan. See Chapter 8 for more information on WMAs.

Point and Nonpoint Source Water Pollution

A "point source" of pollution is defined in §502(14) of the federal Clean Water Act as "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged." Point sources are regulated by National Pollutant Discharge Elimination System (NPDES) permits.

The term "nonpoint source" is defined as any source of water pollution that does not meet the above legal definition of a "point source." Nonpoint sources are typically described as those emanating from precipitation that has picked up natural and human-made pollutants as it moves over and through the ground. The US EPA lists fertilizers, herbicides, pesticides, oil and grease, sediments and bacteria and nutrients as examples of nonpoint source pollutants. Septic systems, despite the fact that they introduce nutrients and other contaminants into the groundwater are considered non-point sources of pollution and are therefor not regulated by US EPA.

Regulations and Enforcement

At the present time, there is no federal law that requires the regulation of nonpoint source water pollution in a way that gives rise to enforcement actions. Given the scope of the CWA and the nature of wastewater management on the Cape, US EPA permit requirements do not apply to Cape Cod and the reach of the CWA on Cape Cod is limited to planning and the development of TMDLs for impaired waters.

Cape Cod has recently been the subject of a lawsuit on this issue in the matter of Conservation Law Foundation (CLF) and the Buzzards Bay Coalition (BBC) v. the United States Environmental Protection Agency et al. The original lawsuit asserted that the US EPA violated the Clean Water Act and its regulations by failing to properly regulate nonpoint sources resulting in increased nitrogen levels which have degraded the embayments in a manner that has injured the recreational, commercial and aesthetic interests in those waters. This lawsuit was dismissed for lack of standing, leaving the underlying claims of the plaintiff unresolved by the courts

In a refiled suit, CLF asserted that the US EPA's mandatory annual review of how Massachusetts administers its State Revolving Fund (SRF) has been contrary to law. Specifically, under the Clean Water Act, the US EPA has the authority to grant money to a state's SRF fund for certain types of wastewater management projects subject to certain restrictions on the use of the funds, with the main one being that funded projects be consistent with approved 208 plans. The US EPA has a duty to review a state's plans and reports concerning the state's use of those funds on an annual basis.

CLF sought an injunction requiring that (1) the US EPA notify the Commonwealth of its noncompliance; and (2) an update to the Section 208 Area Wide Water Quality Management Plan be completed within one year. The US EPA sought and received a stay of this lawsuit until June 1, 2015, pending review and approval of this updated Cape Cod area wide water quality management plan under Section 208 of the Clean Water Act.

Subsequently, on November 17, 2014, CLF and US EPA filed a settlement agreement in US District Court requesting an extension of the existing stay of the Section 208 Action from June 1, 2015 to September 15, 2015, a stay of the TMDL Action until September 15, 2015, and a dismissal of both actions upon completion of a series of actions to be completed by EPA, including the approval of the Cape Cod Section 208 Plan Update.

While the lawsuit sought to change this, direct federal regulation of large nonpoint source water pollution is managed today through non-regulatory means, including assistance to states from federal planning and grant programs under the Clean Water Act. Among the non-regulatory strategies this plan tries to leverage are watershed and land use planning, development of voluntary best management practices, technical assistance programs regulatory reform and cost-sharing for implementation of prevention and control measures.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) STORMWATER PERMIT PROGRAM AND MUNICIPAL SEPARATE STORM SEWER SYSTEMS (MS4)

The Clean Water Act authorizes US EPA and states to regulate point sources that discharge pollutants into waters of the United States through the National Pollutant Discharge Elimination System permit program. These "point sources" are generated from a variety of residential, municipal and industrial operations, including treated wastewater, process water, cooling water, and stormwater runoff into drainage systems. The NPDES Stormwater Program regulates discharges from certain municipal separate storm sewer systems (MS4s), construction activities, and industrial activities. The US EPA Regional Administrator may also designate needed stormwater controls for discharge based on waste load allocations that are part of a TMDL that address the pollutant of concern. See 40 CFR §122.26(a)(9)(i)(C) and (D)(relating to discharges that the Regional Administrator determines are a significant contributor of pollutants or contribute to a violation of water quality standards).

On Cape Cod, all communities except Truro and Provincetown are expected to be subject to newly issued regulation under the MS4 permit program.

The Clean Water Act provides that municipal and industrial stormwater permits "shall require controls to reduce the discharge of pollutants to the maximum extent practicable,

including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants" CWA Section §402(p)(3)(B)(iii).

Municipalities not only have to control pollutants to the maximum extent practicable, but also have to effectively prohibit non-stormwater discharges into the system and comply with provisions as deemed by the Regional Administrator or, in states with an approved NPDES program, the State Director.

The definition of MS4s includes but is not limited to: stormwater outfalls, roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, and/or storm drains. The complete definition may be found at 40 CFR §122.26(b)(8).

The Cape communities south and west of Eastham are currently operating under an administrative extension to the 2003 MS4 permit, which remains enforceable and in effect administratively with all of terms and conditions until a new permit is issued. US EPA Region 1 published a 2014 Draft Massachusetts MS4 Permit on September 30, 2014; the comment period for the draft permit closed on February 27, 2015.

The draft Massachusetts MS4 permit has six minimum measures:

- Public education and outreach
- Public involvement
- Illicit discharge detection and elimination
- Construction runoff
- Post construction stormwater management
- Pollution prevention

For more information about the draft permit, see: http://www.epa.gov/region1/npdes/stormwater/MS4_MA.html. In addition, US EPA anticipates issuing a separate small MS4 permit for the Massachusetts Department of Transportation (MassDOT) in the near future.

The 2003 MS4 permit established goals and metrics geared toward improving water quality in water bodies regulated under the Clean Water Act. Municipalities were required to develop, implement, and enforce a stormwater management program designed to control pollutants to the maximum extent practicable in the watershed. The "maximum extent practicable" standard is a flexible goal intended to be met through an iterative process. Municipalities implement their stormwater management programs through best management practices (BMPs), periodically assess the effectiveness of the BMPs, and then make revisions to address ineffective elements of the program, and improve pollutant control.

Presently there are approved TMDLs for nitrogen in many of Cape Cod's coastal embayment systems. The Massachusetts Estuaries Project (MEP) technical reports for Cape Cod watersheds identify MS4 sources as comprising 3%-17% of the controllable watershed nitrogen load, depending on the watershed studied. It has been anticipated that the new permit will contain specific regulations for discharges subject to an approved TMDL to better address specific pollutant problems in regulated water bodies.

For the "Cape Cod Nitrogen TMDL's," the 2014 draft Massachusetts MS4 permit seeks nitrogen reduction through enhanced Best Management Practices for discharges to nutrient impaired waters or their tributaries, with a focus on public education, new development/redevelopment and good housekeeping. For discharges to waterbodies without an approved TMDL, there are still requirements for bacteria, nutrients, solids, chloride, metals and oils and grease. A Nutrient Source Identification Report, which is due on year four from the date of the issuance of the permit, seeks the delineation of potential nitrogen or phosphorus sources, an identification of potential retrofits, one demonstration project by year six, and the tracking of nitrogen or phosphorus reductions through the implementation of structural BMPs.

Towns should be prepared to respond to the draft small MS4 general permit soon after its issuance. To seek coverage under the small MS4, towns must file a Notice of Intent (NOI) within 90 days of US EPA's issuance of the final MS4 permit following the public comment period. Requirements for the NOI filing include: the location of the current Stormwater Management Program (website or physical address), status of outfall map, a summary of the status of relevant bylaws/ordinances, identification of the number of outfalls contributing to receiving waters and a summary of the current Stormwater Management Program.

MassDOT is recognized as a regulated entity with a separate individual small MS4 permit anticipated to be released in the near future. State roadways operated by MassDOT in watersheds to impaired water resources also contribute nutrients and other pollutants from stormwater. **Figure 3-1** shows the state roadways that intersect water resources with completed TMDLs for nitrogen, are pending MEP analysis, and/or are listed on §305(b) or §303(d) Integrated List of Waters. See Chapter 7 for specific recommendations for working with MassDOT to improve stormwater management on state roadways.

For more information about the MS4 Permit Program, see http://epa.gov/region1/npdes/stormwater/. Chapter 6 provides a discussion of stormwater utilities as a means of raising stable and adequate revenue to fund stormwater improvements and maintenance.

NPDES AUTHORITY

The CWA allows the US EPA to authorize the NPDES Permit Program to state governments, enabling states to perform many of the permitting, administrative, and enforcement aspects of the NPDES Program. Currently, the US EPA has authorized all but five states to participate in some capacity in the administration and enforcement of NPDES permits. Massachusetts is not a delegated state under the NPDES permit program. NPDES permits are jointly issued by the US EPA and the MassDEP and are equally and separately enforceable by both agencies. Presently, there are various methods used to monitor NPDES permit conditions. According to the US EPA, these include the following:

2012 Integrated List of Waters 305(b) 303(d)

Figure 3-1

- The permit requires the facility to sample its discharges and notify US EPA and the state regulatory agency of its results.
- The permit also requires a facility to notify US EPA and the state regulatory agency when the facility determines it is not in compliance with the requirements of a permit.
- US EPA and state regulatory agencies also send inspectors to companies in order to determine if they are in compliance with the conditions imposed under their permits.

Federal law provides US EPA and authorized state regulatory agencies with various methods of taking enforcement actions against violators of permit requirements. These include the authority for US EPA and state regulatory agencies to issue administrative orders requiring facilities to correct violations and assess monetary penalties. The US EPA and state agencies may also pursue civil and criminal actions that may include mandatory injunctions or penalties, as well as jail sentences for persons found willfully violating requirements and endangering the health and welfare of the public or environment.

To the extent a locally proposed solution results in the need for a NPDES permit, providing the Commonwealth of Massachusetts permitting and enforcement abilities that the majority of the United States currently exercise will enable the locality to pursue the streamlined process that the Section 208 Plan proposes. Delegating such authority to the Commonwealth of Massachusetts in conjunction with its newly produced action plan pursuant to Section 208 is in line with its proposal and it's consideration is recommended as part of this plan.

Recommendation R3.1: The Commonwealth of Massachusetts should seek delegated authority under the Clean Water Act to issue and enforce NPDES permits.

REQUIREMENTS AND GOALS

The lack of direct federal NPDES permitting on Cape Cod means that much of the regulatory load is carried by the Commonwealth of Massachusetts through the Department of Environmental Protection (MassDEP). Wastewater discharges are currently regulated in the Commonwealth through the following means:

- **SEPTIC SYSTEMS**: Regulation of septic systems is delegated by the state to municipalities under the jurisdiction of the Boards of Health in each city or town in accordance with 310 CMR 15.000 (Title 5). The BOH role is to ensure that the systems are installed and maintained according to code.
- **GROUNDWATER DISCHARGES (VOLUMES OVER 10,000 GALLONS PER DAY)**: MassDEP issues Groundwater Discharge Permits for facilities that discharge to the ground. At a minimum, these permits require secondary treatment with a nitrogen limit of 10 milligrams per liter (mg/l) before discharging to the ground. Groundwater discharge permits are prominent on Cape Cod.
- **SURFACE WATER DISCHARGES (NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM [NPDES] PERMIT)**: MassDEP issues these permits jointly with the US EPA. These permits for discharge to surface waters have end of the pipe effluent limits for pollutants of concern, like nitrogen and phosphorus, which comply with the surface water quality standards.

These permitting processes are part of a set of regulatory programs that, taken together, provide a framework of tools to manage, somewhat imperfectly, the water quality challenges facing Cape Cod. There is no single regulatory program with the scope and authority to successfully manage Cape Cod waters, so these separate programs and tools must be woven together, reformed and used in new ways.

STATE TITLE 5 REGULATIONS ON WASTEWATER FLOWS

MassDEP regulates wastewater flows less than 10,000 gallons per day under 310 CMR 15.000: The State Environmental Code, Title 5: Standard Requirements for the Siting, Construction, Inspection, Upgrade and Expansion of On-Site Sewage Treatment and Disposal Systems and for the Transport and Disposal of Septage (typically referred to as Title 5). Title 5 typically covers such uses as conventional on-site septic systems, alternative systems, such as denitrifying systems (often called "Innovative/ Alternative," or I/A, systems), as well as composting toilets

and other kinds of systems in use on individual properties or cluster developments. Title 5 presumes residential wastewater flows at 110 gallons per day per bedroom (e.g., Title 5 presumes that a four-bedroom house will generate 440 gallons per day, and that one 440 gpd septic system per acre is protective of drinking water quality). Non-residential wastewater generation is typically based on use and square footage, or for example, the number of restaurant seats.

MASSACHUSETTS GROUND WATER QUALITY STANDARDS

Massachusetts Groundwater Quality Standards

Massachusetts applies a number of regulations protective of groundwater, many of which are also protective of surface waters because contaminants affecting groundwater quality, e.g. nitrogen, ultimately discharge to surface waters. Massachusetts Groundwater Quality Standards, 314 CMR 6.00, were rescinded in 2009 because revisions to 314 CMR 5.00 eliminated the need for this regulation.

Primary regulations protective of groundwater include:

- Drinking Water Regulations (310 CMR 22.00)
- Groundwater Discharge Program (314 CMR 5.00)
- Septic System regulations (310 CMR 15.00; Title 5)
- Land Application of Sludge and Septage Wastewater & Sewer Regulations (310 CMR 32.00)
- Supplemental Requirements for Hazardous Waste Management Facilities (314 CMR 8.00)
- Reclaimed Water Regulations (314 CMR 20.00)
- Wetlands Protection Act Regulations (310 CMR 10.00, including the Massachusetts Stormwater Policy and Guidelines)
- Massachusetts Contingency Plan (310 CMR 40.0000)

GROUNDWATER DISCHARGE PERMITS

Flows in excess of 10,000 gallons per day are regulated under the state Groundwater Discharge Permit Program (See 314 CMR 5.00 Groundwater Discharge Permit Program). Systems requiring a groundwater discharge permit require significant removal of nitrogen because the Cape Cod Aquifer is designated as a non-degradation resource. Groundwater discharge permits for Cape Cod require an effluent treatment level of at least 10 milligrams per liter of nitrate, which is almost a two-thirds reduction in the amount of nitrogen leaving a septic system, although not low enough to achieve or maintain marine water quality. In the last 10 years, groundwater discharge permits for projects located in watersheds to nitrogen impaired embayments have been held to a “no-net nitrogen” standard by MassDEP. This means that any nitrogen released into the watershed must be “offset” by the removal of nitrogen from an existing source. To date, this typically occurs by connecting a nearby existing development to remove nitrogen via wastewater treatment.

MASSACHUSETTS SURFACE WATER QUALITY STANDARDS

Following federal law, and as prescribed by the federal Clean Water Act, the Commonwealth of Massachusetts adopted surface water quality standards for individual water bodies. The standards designate the most sensitive uses for which the water body must be “enhanced, maintained, and protected” (whether or not the designated use is currently attained), prescribe minimum water quality criteria necessary to sustain the designated uses and contain the regulations necessary to achieve and maintain the designated use and, where appropriate, prohibit discharges.

Massachusetts divides coastal and marine surface waters into three classes: SA, SB, and SC, in descending order of the most sensitive uses that water body must attain. Additionally the state has special designations of Outstanding Resource Waters, Special Resource Waters, Shellfish (waters), and Warm Water. A brief description of these classes and special designations follows. For more information see M.G.L. c. 21, §27. 314 CMR 4.00: Massachusetts Surface Water Quality Standards.

SA Waters are designated as the highest quality, providing excellent habitat for marine life and for primary and secondary contact recreation. In certain waters, excellent habitat may include seagrass and, where designated for shellfishing, SA waters are suitable for shellfish harvesting without depuration (process of removing impurities). Nearly all of the coastal waters of Cape Cod have been classified as SA.

SB Waters are designated as habitat for marine life and for primary and secondary contact recreation. In certain waters, habitat may include seagrass. Where designated for shellfishing, these waters are suitable for shellfish harvesting with depuration. Several water bodies on Cape Cod have been classified as SB waters, particularly those that are used heavily for shipping and boating.

SC Waters are designated as habitat for marine life and for secondary contact recreation. They may also be suitable for certain industrial cooling and process uses. There is no water body on Cape Cod that has been classified as SC.

Outstanding Resource Waters (ORW) denotes waters that "include Class A Public Water Supplies (314 CMR 4.06(1)(d)1) and their tributaries, certain wetlands as specified in 314 CMR 4.06(2) and other waters as determined by the department based on their outstanding socio-economic, recreational, ecological, and/or aesthetic values." An application to nominate a water body as an ORW must be submitted in accordance with applicable department application procedures and requirements. Areas of Cape Cod that have been designated as ORW include waters within and adjacent to the Cape Cod National Seashore and Areas of Critical Environmental Concern (ACECs). See Appendix 3A for a list of ACECs.

Shellfishing Waters are subject to more stringent regulation in accordance with the rules and regulations of the Massachusetts Division of Marine Fisheries.

Warm Waters are those waters in which the dissolved oxygen and temperature criteria for warm-water fisheries apply. This designation applies only to fresh water bodies.

There is a provision to remove a designated use through a Use Attainability Analysis (UAA) persuant to 40 CFR 131.10(g). The towns of Eastham and Orleans have begun discussions with the state regarding an UAA for Rock Harbor.

IMPAIRED WATERS AND TOTAL MAXIMUM DAILY LOADS

Massachusetts submits a list of the conditions of surface waters to the US EPA every two years in compliance with the Clean Water Act. The "Integrated List of Waters" identifies each water body or segment of a water body as supporting a designated use or as impaired. With the Integrated Report option, US EPA encourages states to use a five-category system for classifying all water bodies (or segments) within its boundaries regarding the waters' status in meeting the state's water quality standards. The categories are listed below in **Table 3-1**. The classification system uses designated uses as the basis for reporting on water quality.

The waters from Category 5 constitute the Section 303(d) list of impaired or threatened waters within the State boundaries. In addition to the 303(d) report, the CWA requires that each state report every two years on the health of all its waters, not just those that are impaired. Information from this report, known as the 305(b) report or "biennial water quality report," has historically been used

CATEGORY/SUBCATEGORY	DESCRIPTION
Category 1	All designated uses are supported, no use is threatened.
Category 2	Available data and/or information indicate that some, but not all, designated uses are supported.
Category 3	There is insufficient available data and/or information to make a use support determination.
Category 4	Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed.
Category 4a	A State developed TMDL has been approved by US EPA or a TMDL has been established by US EPA for any segment-pollutant combination.
Category 4b	Other required control measures are expected to result in the attainment of an applicable water quality standard in a reasonable period of time.
Category 4c	The non-attainment of any applicable water quality standard for the segment is the result of pollution and is not caused by a pollutant.
Category 5	Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed.

Five Category System for Classifying Waterbodies

Table 3-1

to develop the "threatened and impaired waters" list. Most states compile the data and findings from the 305(b) report and add information from other sources, such as the state's report of waters affected by nonpoint sources (CWA §319), to produce the 303(d) list. EPA recommends that states combine the threatened and impaired waters list, 303(d) report, with the 305(b) report to create an "Integrated Report," due April 1 of even-numbered years.

The most recent impaired waters list for Massachusetts, including Cape Cod waters, is the Massachusetts Year 2012 Integrated List of Waters. As of the date of this report, the Massachusetts Year 2014 Integrated List of Waters is still considered draft.

The Clean Water Act, under §303(d), requires states to assess the quality of surface waters based on the intended uses identified in the state Water Quality Standards on a regular basis and to develop a list, referred to as the 303(d) list, of impaired waters detailing those waters that do not meet the intended uses. The Clean Water Act requires all states to submit for US EPA approval every two years on even-numbered years a list of impaired and threatened waters. The states identify all waters where required pollution controls are not sufficient to attain or maintain applicable water quality standards, and establish priorities for development of TMDLs based on the severity of the pollution and the sensitivity of the uses to be made of the waters, among other factors. States then provide a long-term plan for completing TMDLs within 8 to 13 years from first listing.

Under §303(d) of the Clean Water Act, states are required to:

- Identify those water bodies that are not expected to meet the Surface Water Quality Standards from technology-based controls; and,
- Establish, subject to US EPA approval, for those water's TMDLs—the maximum amount of a pollutant from any source and of any kind that a water body can have without violating water quality standards.

On Cape Cod, state-developed TMDLs are based on technical reports prepared by the MEP. TMDLs are formulated by MassDEP and submitted to US EPA for approval after public comment. The TMDLs are utilized as the standards MassDEP and other regulatory authorities use to determine whether their regulations are met as required by the Federal Clean Water Act.

NONPOINT SOURCE MANAGEMENT PLAN

Massachusetts developed a nonpoint source management (NPS) plan in 1988 pursuant to §319 of the Clean Water Act. This plan, updated most recently in 2014, is an integrated strategy for the prevention, control and reduction of pollution from nonpoint sources. As part of the 2014 update, the MA Office of Coastal Zone Management also updated its Coastal Nonpoint Pollution Program 5-Year implementation Plan and 15-Year Program Strategy, and included it in the statewide plan. Federal funds are available for activities such as technical assistance, education, training, technology transfer, watershed restoration and demonstration projects. Only those implementation strategies identified in the management plan are eligible for federal funding. In addition to the NPS Management Plan, in 2006 MassDEP developed a Clean Water Toolkit (also known as the Massachusetts Nonpoint Source Pollution Management Manual) that provides information about the nonpoint source management measures that can be used in Massachusetts. Both the 2014 Massachusetts Nonpoint Source Management Program Plan and the Toolkit can be found at http://www.mass.gov/eea/agencies/massdep/ for more information.

SAFE DRINKING WATER ACT

The US EPA Primacy Agent for the Federal Safe Drinking Water Act is the MassDEP, Division of Watershed Management's Drinking Water Program. On behalf of the US EPA, MassDEP regulates water quality monitoring, new source approvals, water supply treatment, distribution protection and the reporting of water quality data

The Safe Drinking Water Act (SDWA) is the main federal law that protects the quality of drinking water and the rivers, lakes, reservoirs, springs and groundwater wells that are the source of drinking water. The Act authorizes the US EPA to set standards for drinking water quality to protect against natural and human-caused contaminants and to oversee the implementation of those standards on the state, local and water supplier levels. At present, there are standards that regulate 83 different contaminants. Cape Cod was designated a Sole-Source Aquifer under the Safe Drinking Water Act in 1982.

The Act applies to the more than 170,000 public drinking water systems in the country and requires their evaluation by third party analytical laboratories. The Act does not

cover systems that service fewer than 25 individuals or apply to bottled water. There are 17 SDWA regulated public water suppliers on Cape Cod.

DRINKING WATER AND ZONE II WELLHEAD PROTECTION AREAS

Massachusetts' drinking water regulations (310 CMR 22.00) are intended to protect public health by ensuring that all water used for public consumption is safe, fit and pure to drink. The regulations identify contaminants that must be controlled, establish limits on the allowable concentrations of these contaminants and mandate the type and frequency of monitoring required, ensuring compliance with the regulations.

The regulations define a Zone I as "the protective radius required around a public water supply well or wellfield" and a Zone II as "that area of an aquifer that contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated." Zone IIs are also known as wellhead protection areas and all Cape towns have protected them through zoning and Board of Health bylaws. Municipalities identify areas as potential Zone IIs and submit them to the state. Zone I areas are roughly 11 acres large and must be controlled by the public water supplier. Zone IIs are much larger and are subject to protection from the siting of discharges, landfills and other potentially hazardous land uses.

WATER POLLUTION ABATEMENT DISTRICTS

MassDEP may propose the creation of water pollution abatement districts (WPAD) consisting of one or more cities or towns, or designated parts thereof. If MassDEP deems that such a district is necessary for the prompt and efficient abatement of water pollution, it may, after a public hearing, mandate the formation of such a district.

Districts can be proposed by a town or by MassDEP; if it is the latter, a town must take a vote at Town Meeting within 90 days of the nomination. If the town meeting votes against the establishment of a WPAD, MassDEP may hold a hearing with the Water Resources Commission if it finds that the creation of a district is "necessary for the prompt and efficient abatement of water pollution."

Once created, each district is its own independent entity administered by a "district commission." Representatives of the town may comprise the WPAD, but MassDEP may mandate that their agency appoint members (with approval of the Water Resources Commission).

After its creation, the district has one year to present an abatement plan to MassDEP (or a lesser time as established by MassDEP) that contains the source of pollution, the means by which to abate it, and proposed projects for the solution. Once formed, the WPAD may only be dissolved by an act of the Legislature.

The source of authority for WPADs is the Massachusetts Clean Waters Act (M.G.L. c. 21, §§28-30, 32, 35, 36). The Act enables towns to:

- Adopt bylaws/regulations
- Acquire, dispose of and encumber real/personal property (including eminent domain powers)
- Construct, operate and maintain water pollution abatement facilities
- Apportion assessments on the member municipalities
- Issue bonds and notes and raise revenues to carry out the purposes of the district

Member municipalities may then impose assessments on residents, corporations and other users in the district. If a town fails to pay its share, the state may pay it for them out of other funds appropriated to that town.

COMPREHENSIVE WASTEWATER MANAGEMENT PLANS

Currently, individual municipalities develop Comprehensive Wastewater Management Plans (CWMPs) within town boundaries. These plans include watersheds that are both wholly within town boundaries, and watersheds that are shared with a neighboring town. MassDEP considers requests for municipal permits and financing after a state level environmental scoping review is conducted under the Massachusetts Environmental Policy Act (MEPA). MEPA thresholds mandate review for construction and upgrades to wastewater treatment and disposal facilities (MEPA Regulations 301 CMR 11.03 Review Thresholds). Specifically, MassDEP reviews CWMPs under MassDEP "Selection, Approval and Regulation of Water Pollution

Abatement Projects Receiving Financial Assistance from the State Revolving Fund" (310 CMR 44.00). CWMPs have traditionally recommended conventional wastewater sewer collection and treatment facilities, which require a groundwater discharge permit and sewer construction permits. The filing of a CWMP with MEPA typically requires the preparation of an Environmental Impact Report (EIR) which also triggers mandatory regulatory review by the Cape Cod Commission.

The MassDEP Division of Municipal Services Guide to Comprehensive Wastewater Management Planning outlines the process for development of a CWMP. According to the guidance, "The planning exercise requires a community to perform a needs analysis: identifying problem areas including areas with poor soils, areas with failing septic systems and densely developed areas. Different wastewater treatment options including on-site septic systems, decentralized systems, or a centralized community-wide system are also analyzed for applicability in addressing the identified wastewater issues while considering environmental concerns (groundwater recharge, pollution prevention) and costs. Public input is sought throughout the CWMP process."

MEPA AND OTHER STATE PERMITTING REQUIREMENTS

As discussed above, CWMPs typically require MEPA review prior to state and regional permitting. MEPA review involves scoping proposed projects for their potential environmental impacts, identifying alternatives, and avoiding, minimizing or mitigating environmental impacts. CWMPs are typically filed first as an Environmental Notification Form (ENF) or Expanded ENF with a Draft Environmental Impact Report (DEIR) and released for public comment. At the end of public comment, the Secretary of Energy and Environmental Affairs will issue a Certificate of Adequacy that outlines additional information or analysis that should be conducted prior to the next MEPA filing. The final MEPA filing is a Final Environmental Impact Report (FEIR). Upon the Secretary's issuance of a Certificate of Adequacy for an FEIR, appropriate state agencies and the Cape Cod Commission then commence their regulatory reviews (See, 301 CMR 11.). CWMPs typically trigger EIR review because they involve construction of a new wastewater treatment and disposal facility with a capacity of 2,500,000 gallons per day, or because they result in construction of one or more new sewer mains 10 or more miles long. CWMPs may also trigger mandatory EIR thresholds for land and wetland alterations, impacts to endangered or threatened species or archeological sites, and other factors. In addition to MassDEP regulatory review, other state agency permits may include: Massachusetts Natural Heritage and Endangered Species Program; Massachusetts Historical Commission; Massachusetts Division of Marine Fisheries, and others.

Barnstable County Requirements and Goals

CAPE COD COMMISSION

The Cape Cod Commission, the Cape's regional planning agency, was created by an act of the Massachusetts Legislature and ratified by the voters of Barnstable County in 1990 in response to the rapid development pressure of the 1980s. The increased pace of development focused attention on the need to manage growth, guide land use, promote balanced economic growth, provide for adequate capital facilities and infrastructure, and protect environmental resources. The Commission has planning, technical and regulatory tools that can be applied to water quality management on Cape Cod. The Commission has independent statutory authority and is a department within the structure of Barnstable County government.

DRI REVIEW OF MUNICIPAL COMPREHENSIVE WASTEWATER MANAGEMENT PLANS

A Development of Regional Impact (DRI) is a proposed development that is likely to present development issues significant to more than one municipality in Barnstable County. Projects are referred to the Cape Cod Commission for review as DRIs by a variety of means. The Commission is required to review the proposed development and either approve, approve with conditions, or deny the development proposal.

3

CAPE COD REGIONAL POLICY PLAN

The Cape Cod Commission Act (Act) established a Commission regulatory function to review and approve, condition, or deny development projects that exceed Development of Regional Impact thresholds. The Act includes a provision that the Commission develop and implement a Regional Policy Plan (RPP) that contains the minimum performance standards (MPS) for its regulatory review of proposals. The Commission published the first version of the Regional Policy Plan in 1991; it has been updated and revised every five years.

The initial water resources section of the Regional Policy Plan recognized that many of the Cape's embayments were suffering from water quality impacts associated with nitrogen from septic systems. In the late 1990s the plan's minimum performance standards for development not exceeding a critical nitrogen loading limit and maintaining or improving coastal water quality were interpreted as the "no net" nitrogen load policy. This means that development in a watershed to a nutrient-overloaded system cannot add any more nitrogen to the watershed or that the amount of nitrogen added by the project must be offset by an equivalent reduction.

The "no net" policy may be achieved by (1) providing wastewater treatment for the development or redevelopment and additional treatment capacity for nearby land uses; (2) installation of alternative denitrifying technologies for existing septic systems in the same Marine Water Recharge Area; and/or, (3) an equivalent monetary contribution of $1,550 per kilogram per year of nitrogen towards a municipal or watershed effort that achieves the intent of the "no net" load policy. The implementation of the policy was fairly successful and accepted by the towns and the regulated community. It resulted in increased levels of wastewater treatment from proposed package plants, the construction of package plants with excess capacity to hook in neighboring areas, and hundreds of thousands of dollars in mitigation funds for towns to pursue mitigation and/or CWMP development. Most importantly, it resulted in an acceptance that coastal eutrophication is an important matter for Cape Cod and that better treatment of wastewater is required.

The 2009 Regional Policy Plan changed the "no net" policy to reflect the newly adopted TMDLs by MassDEP and US EPA as the critical nitrogen loading limit. The performance standard interprets the adopted TMDL as a "fair share." The fair share is the TMDL equivalent load on a per-acre rate using the watershed and sub-watershed area. Fair-share nitrogen loads are calculated as the threshold controllable nitrogen load necessary to achieve TMDL compliance in the applicable surface water body, as indicated by the Massachusetts Estuaries Project, apportioned to the project in proportion to the size of the project area relative to the area contributing to applicable surface water body.

DRI project nitrogen loading calculations are reviewed to evaluate how a proponent could best meet the intent of the fair share. The Commission has developed a methodology to assist in calculating a project's nitrogen load and to compare its respective mitigation amount under the fair share.

The Commission's regulatory review of a CWMP is presently guided by the planning guidance and minimum performance standards of the Regional Policy Plan. The pertinent technical sections of the RPP include water resources, open space, natural resources, planning and historic preservation. Some of the requirements are similar to MassDEP requirements, but some are quite different. The pertinent standards from the RPP water resources section are available in Appendix 3B.

JOINT REVIEW PROCESS

As mentioned above, municipalities are typically required to file an EIR with the MEPA for the development of CWMPs. The Cape Cod Commission Act § 12(i) requires that the Commission shall review as a DRI any proposed development project for which the Massachusetts Secretary of Energy and Environmental Affairs (Secretary) requires the preparation of an Environmental Impact Report. As a result, at the conclusion of the MEPA process, the Commission conducts a regulatory review, and issues a written approval decision containing findings and conditions for all CWMPs proposed by Cape Cod towns.

A November 1991 Memorandum of Understanding (MOU) between the Commission and MEPA states that the environmental review processes of the Commission and the MEPA Unit are, in some instances, overlapping and that the environmental review procedures are similar. As

such, the MOU was executed given the extensive overlap of the statutory responsibilities of the Commission and the Secretary with respect to development on Cape Cod, in order to establish a coordinated review process for development projects that are subject to both Commission and MEPA review. The MOU establishes a coordinated voluntary Joint Review Process (JRP) for projects that are subject to MEPA and deemed to be DRIs pursuant to the Cape Cod Commission Act. The seventeen-step process is outlined as an attachment to the MOU. See Appendix 3C for the MOU.

DISTRICTS OF CRITICAL PLANNING CONCERN

The Cape Cod Commission Act provides for the designation of certain areas of critical value to Barnstable County as Districts of Critical Planning Concern (DCPCs).

A DCPC is a planning tool that allows for the adoption of special rules and regulations to protect, preserve, or promote an area, depending on the purpose of the DCPC. Certain local boards and commissions may nominate land within their own municipal boundaries, as well as land in a contiguous town (for example, a town could nominate land in a shared watershed to a nitrogen-sensitive embayment that lies within a neighboring town), as a DCPC. DCPCs may also be nominated by the Cape Cod Commission, the Board of County Commissioners and the Barnstable County Assembly of Delegates. Upon nomination to the Commission, the DCPC is considered by the Commission, which may in turn recommend it to the Assembly of Delegates and County Commissioners for adoption by county ordinance. Ultimately, implementing regulations are adopted and locally enforced by the town(s) to carry out the purposes of the DCPC. With the district designation comes a 12-15 month moratorium on certain development; the development moratorium is limited to specific development proposals as deemed necessary to support the purposes of the nominated district.

In terms of wastewater management or nitrogen control, as one example, a DCPC could be used to specify growth expectations in watersheds that are shared between one or more towns. The DCPC is a very flexible land use planning tool that could have many applications for water quality and growth planning on the Cape.

DCPCs are discussed further in Chapter 7 and a full list of designated DCPCs is available in Appendix 7A.

Other Regulations - Municipal

BOARD OF HEALTH REGULATIONS

Municipalities have authority and responsibility over wastewater flows within their jurisdiction in several ways. Boards of Health have jurisdiction over on-site septic systems and are responsible for enforcing compliance with Title 5 on the local level. Title 5 is a state minimum code, although municipalities may impose stricter standards then those found in Title 5. Under Title 5, Board of health responsibilities include:

- issuing permits and licenses for septic systems, septic installers and sewage haulers;
- controlling lot sizes and setbacks for purposes of siting septic system components;
- conducting inspections of septic systems;
- permitting the use of alternative systems, including denitrifying septic systems; and,
- mandating monitoring of alternative systems where applicable.

Boards of Health are responsible for defining what constitutes a bedroom for the purposes of septic system design flow requirements.

Boards of Health may also promulgate regulations more strict than imposed by Title 5. For example, under Title 5 a leaching field must be located at least 50 feet from a coastal bank, coastal dune, coastal beach, salt marsh, or vegetated wetland bordering on any creek, river, stream, pond, or lake. All Cape towns have increased this setback to 100 feet. Boards of Health may also issue variances and exemptions from certain requirements of local regulations.

In towns with sewers, Boards of Health or Sewer Commissions also promulgate water and sewer regulations. Several Cape Cod towns have implemented nutrient management controls through board of health regulations or general bylaws. Boards of Health have also adopted interim regulations for protection of saltwater estuaries. Some towns have taken steps to address flow-related growth potential through sewer connection regulations. These regulations limit flow to what existed before sewering

or to a small increase. These regulations are "growth neutral" in terms of design flow but do not address non-flow related criteria such as siting and setbacks.

Sewer-connection regulations set limits on the amount of wastewater flow to ensure that the capacity of a planned treatment plant is not exceeded and that TMDLs are met at present and in the future.

CONSERVATION COMMISSION REGULATIONS

WETLANDS PROTECTION

Although the jurisdiction of a local conservation commission is restricted to the delineated wetlands resource area and the 100-foot designated buffer (200 feet if the resource area meets the regulatory definition of a riverfront; 100 feet if it meets the requirement for a certified vernal pool), communities may expand the Massachusetts Wetlands Protection Act "protected interests" to include additional conservation values deemed important to the community. Like with Title 5, the WPA is a minimum code and communities may adopt more stringent wetlands rules for their community. The Massachusetts Association of Conservation Commissioners recommends that communities expand protected interests to include:

- Water quality, including surface water bodies
- Erosion/sedimentation control
- Natural habitat, wildlife habitat, rare species habitat, and wildlife corridors
- Agriculture, aquaculture, and shellfisheries
- Storm damage prevention, including coastal storm flowage
- Prevention and control of pollution
- Recreation

By including these as protected interests, the Conservation Commission has the ability to comment and impose conditions on proposed projects that may threaten resources that are no longer protected due to the elimination of Title 5 criteria.

Conservation Commissions may expand their jurisdiction over proposed projects by changing their bylaws and regulations that concern resource areas and buffer zones. Many Cape towns have established "No Build" and "No Disturb" zones within the 100-foot buffer. In no-build zones, no structures can be placed but some pruning is allowed. In no-disturb zones, no alteration can be made, including disturbing vegetation. Conservation Commissions can also extend jurisdiction by expanding the buffer zone beyond 100 feet.

The Cape Cod Commission has a model bylaw that provides language to extend the buffer zone to 200 feet for riverfronts in concordance with the riverfront amendments to the Massachusetts Wetlands Protection Act. Other language also expands the buffer to 300 feet for coastal plain pond shores, 350 feet for vernal pools, and 300 feet for wetlands that are designated as estimated habitat for rare species by the Massachusetts Natural Heritage and Endangered Species Program and for areas within Areas of Critical Environmental Concern.

Conservation Commissions may have jurisdiction when a septic system is upgraded if the existing system is not located with adequate depth to groundwater or if the leach field is less than the distance required from a wetland resource. If an existing system is repaired or upgraded, the new system must meet the requirements of the 100-foot buffer to the extent possible.

A thorough review of zoning and growth management measures and controls is included in Chapter 7 of this plan update.

LOW-IMPACT DEVELOPMENT

Low-impact Development (LID) is a comprehensive, conservation-based approach to land use planning. LID maintains the pre-development hydrology of a site through the use of natural stormwater best management practices including bio-retention filters, vegetated swales, shared driveways, pervious concrete, green roofs, and other strategies that promote the infiltration, filtering, storage, and evaporation of water on location. To date, none of the Cape towns have implemented comprehensive town-wide LID bylaws. However, several towns have adopted measures to improve stormwater treatment. For example, in 2011 the town of Brewster adopted Chapter 115 (Illicit Discharges bylaw) governing discharges to municipal storm systems. The Town of Dennis adopted a stormwater management bylaw in 2009.

NUTRIENTS FROM FERTILIZERS

Fertilizers are included in the nitrogen loading assessment prepared for each watershed by the MEP. With respect to controllable nitrogen loads, the percentage of unattenuated fertilizer load present in the coastal watersheds of Cape Cod ranges from 2% to 20% with an average of 9%.

MUNICIPAL FERTILIZER MANAGEMENT REGULATIONS

The Massachusetts Department of Agricultural Resources released draft regulations in March 2014 pursuant to M.G.L. c. 128, §2(k) and §65(A), as amended by St. 2012, c. 262. 330 CMR 31.00: Plant Nutrient Application Requirements for Agricultural Land and Land Not Used for Agricultural Purposes seeks to establish limitations on the application of plant nutrients to lawns and non-agricultural turf to prevent pollutants from entering surface and groundwater resources. In addition, the regulations ensure that nutrients are applied to agricultural land in a way that provides for plant growth while minimizing the impacts on water resources. Specific limits are proposed for the application of phosphorus: the application of nitrogen is required to be consistent with the University of Massachusetts Extension guidelines for nutrient best management practices for turf.

Barnstable County, through the regulatory authority of the Cape Cod Commission, designated Cape Cod as a Fertilizer Management District of Critical Planning and Concern, allowing municipalities on Cape Cod to further regulate the use of fertilizer. The Cape Cod Commission developed model regulations for use by the municipalities, which incorporate Turf Management Best Management Practices from the University of Massachusetts Extension, and provide specific nitrogen-related limits. For further information see Chapter 7.

Regulating the Solution: Permitting the Watershed

Changes in statute, regulation and practice will be necessary to provide the tools needed to cost effectively solve the water quality problems identified in this plan. The watershed permit is the central feature of the revised regulatory approach.

WATERSHED PERMITTING

The most important factors in defining the successful achievement of TMDL compliance lie with both the designation of the most effective Waste Management Agencies and redefining the watershed permitting process so that (1) the parties designated are those that can do the job; and (2) the process by which this task is achieved is direct and result-oriented.

The Watershed Permit

In reviewing the permitting process as it currently exists, it becomes clear that the jurisdiction of the solution lies within watershed management. Development of a watershed permit that would be obtained through MassDEP plays a central role in achieving compliance with the TMDL on a watershed-by-watershed basis.

Why is a watershed permit approach needed?

The current regulatory approach may not be conducive for the kinds of local plans expected based on recommendations from the Section 208 Plan Update. Non-traditional mitigation strategies may require a different regulatory approach to ensure that watershed-based nitrogen loading targets are met. Compliance points may differ from traditional end-of-pipe effluent limits. Determinations will need to be made on specific permit goals or limits that apply to the range of alternatives that may be considered as wastewater solutions.

How will the watershed permit work?

MassDEP is still evaluating the details of how a watershed permit will be drafted and implemented, as well as what regulatory and statutory changes could help make a transition to a watershed focus. The following will be considered in the development of this permit process:

- Groundwater discharge permit regulations, which are contained at 314 CMR 5.00, are broad enough to incorporate a watershed approach.

- Permits will be issued for one municipality or multiple municipalities in order to facilitate a focus on watersheds instead of decisions that are driven by town boundaries.
- Consideration of the formation of watershed districts and how to permit them will have to be addressed.
- Water quality targets established through the Massachusetts Estuaries Project, state water quality standards, and applicable total maximum daily loads (TMDLs) will be the foundation of the permit.
- Watershed permits will incorporate an appropriate strategy designed to achieve water quality targets based on the consideration of a variety of treatment approaches.
- Monitoring requirements will be incorporated into the permit and will be tailored to the treatment approaches being proposed to ensure that alternatives are resulting in the required nitrogen reduction or remediation.
- Adaptive management will be incorporated into the watershed plans and permits so that MassDEP can allow communities to try various approaches and determine their effectiveness, accurately monitor and assess their performance, and make any necessary changes to the overall approach needed to achieve the ultimate goal—achieving water quality targets in a timely manner.

What are the components to the watershed permit?

Under the watershed permit approach, the nitrogen load is allocated on a watershed by watershed basis. Approaches to allocating responsibility for nitrogen remediation are discussed in greater detail in Chapter 8, as is the requirement for designation of waste management agencies under Section 208 of the Clean Water Act.

The watershed permit will allocate a portion of the load reduction to each management technique being used in each watershed. The permit will establish standards and expectations for performance, define compliance and will establish the protocol for incremental steps for additional management if the initial measures fail to achieve compliance with the water quality standards. By authorizing and including alternative approaches into a permit, the watershed permit would unlock the savings that can come from properly sited and scaled alternative measures where no such permitting mechanism currently exists.

The permit would also implement a Nitrogen Credit Exchange Program that would be created by the Massachusetts Legislature. It would also reference the Nitrogen Credit Advisory Board which would be created by the Legislature to administer the exchange program. If a permittee cannot meet its specified limit, it must purchase equivalent nitrogen credits. Permittees generate credits when they produce less than their specified annual discharge load.

The general permit would establish the framework for WMAs seeking to offset proposed expansion or new construction by allowing the option of purchasing nutrient reductions generated by nonpoint source BMPs.

It is recommended that MassDEP issue guidance regarding watershed permitting.

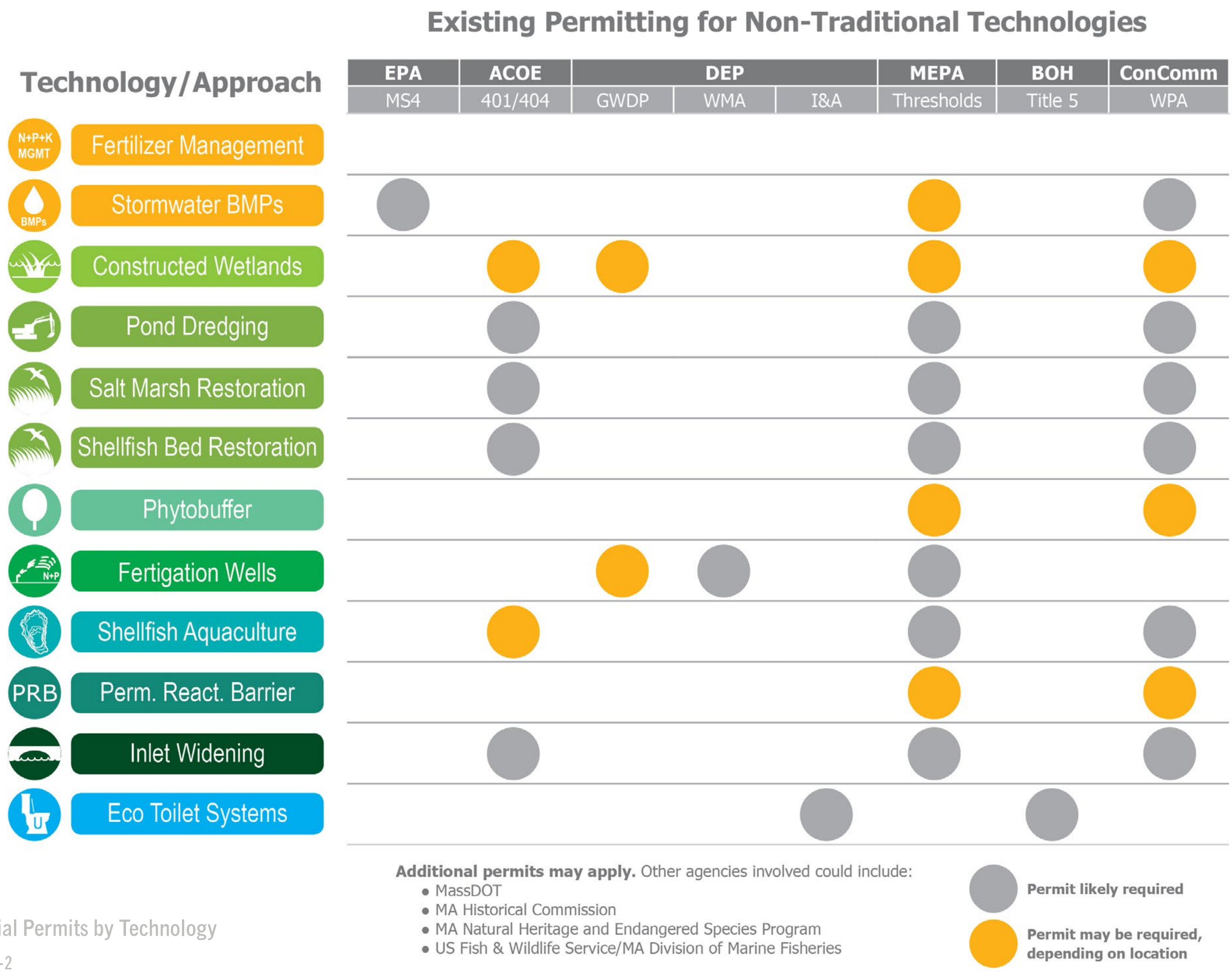
Recommendation R3.2:
MassDEP should issue guidance regarding watershed permitting.

FEASIBILITY OF PERMITTING

In pursuing a watershed approach that encompasses the use of non-traditional technologies along with sewering in discreet areas, one issue that must be addressed is the current permitting process. In reviewing the current process it is clear that implementing the comprehensive process proposed in this plan utilizing the current permitting paths is, at its best, a daunting task, and at its worst, next to impossible (see **Figure 3-2**).

The existing permitting for both sewering and the non-traditional technologies as outlined above may require the following permits:

- Municipal Separate Storm Sewer Systems (known as "MS4") from the Environmental Protection Agency (EPA)
- Groundwater discharge permits from DEP



Potential Permits by Technology

Figure 3-2

3

- Title 5 permits from each town's Board of Health in accordance with 310 CMR 15.00, Surface Water Discharges
- National Pollutant Discharge Elimination System (NPDES) permit from EPA
- An ACOE (Army Corps of Engineers) Section 401 Water Quality Certification that the activity complies with all applicable water quality standards, limitations and restrictions (as a precursor to all federal permits)
- MEPA (Massachusetts Environmental Policy Act) review if it meets the thresholds for review
- Each town Conservation Commission in accordance with the Wetlands Protection Act
- Water Management Act permit from DEP to withdraw over 100,000 gallons/day annually
- DEP and Board of Health approval for use of Innovative and Alternative Technology Systems
- Permits from MassDOT
- Permits from MA Historical Commission
- Approval from the MA Natural Heritage and Endangered Species Program
- Approval form the US Fish & Wildlife Service/ MA Division of Marine Fisheries

A more streamlined process will encourage better planning, enable better intermunicipal cooperation and provide enhanced ability for this plan to be successfully implemented. It is recommended that the watershed permit incorporate and streamline the multitude of permits required to implement a watershed plan.

TITLE 5 DESIGNATION OF NITROGEN SENSITIVE AREAS

MassDEP may identify certain areas as particularly sensitive to pollution from on-site wastewater systems and therefore require the imposition of loading restrictions. These Nitrogen Sensitive Areas (NSAs) include:

- Interim Wellhead Protection Areas and department-approved Zone IIs of public water supplies
- Areas with private wells
- Nitrogen-sensitive embayments or other areas which are designated as nitrogen sensitive under Title 5 based on appropriate scientific evidence

The design flow for wastewater is restricted to 440 gallons per day per acre (gpd/acre) in NSAs and higher levels of nitrogen removal are required. There are exceptions for aggregate flows and systems with enhanced nitrogen removal (typically referred to as Innovative/Alternative or I/A systems). I/A systems are regulated by the state at 310 CMR 15.000. A summary of the DEP approved Innovative/ Alternative systems is located at http://www.mass.gov/eea/agencies/massdep/water/wastewater/summary-of-innovative-alternative-technologies-approved.html. See 310 CMR 15.216 (aggregate flows) and 310 CMR 15.217 (enhanced nitrogen removal) for additional information.

The nitrogen-loading restrictions in NSAs apply to new construction only and do not affect existing Title 5 systems unless they are deemed to have failed or are required to be upgraded at the time of property transfer. Those systems are regulated through the inspection process and the definition of "failing" systems in 310 CMR 15.303 and 15.304. Title 5 has special requirements for repairing failed systems and for the construction of new systems in NSAs.

On Cape Cod, MassDEP has not designated watersheds to embayments that exceed their critical load as "nitrogen sensitive" because the designation would trigger the requirement for new development within the designated area to construct I/A systems. I/A systems are more costly than standard Title 5 systems, and the scenario development work conducted as part of the Section 208 Plan Update demonstrates that even 100% use of I/A systems in many watersheds will not achieve the nutrient reduction levels necessary to meet TMDLs.

MassDEP should consider designating as Nitrogen Sensitive Areas watersheds contributing to waterbodies impaired by nitrogen that are subject to a 208 Plan, whose development primarily relies on on-site septic systems and/or where the water body is listed on the 303(d) list due to nitrogen overloading and modify available remedial actions to allow for appropriate time for waste management agencies to plan. In addition, MassDEP should consider eliminating or amending the regulatory language establishing the presumption that Title 5 systems meet the state water quality standards in situations where it has been established that septic systems contribute to non-attainment.

Recommendation R3.3: MassDEP should consider designating as Nitrogen Sensitive Areas watersheds contributing to waterbodies impaired by nitrogen that are subject to a 208 Plan, whose development primarily relies on on-site septic systems and/or where the water body is listed on the 303(d) list due to nitrogen overloading and modify available remedial actions to allow for appropriate time for waste management agencies to plan.

Recommendation R3.4: MassDEP should consider eliminating or amending the regulatory language establishing the presumption that Title 5 systems meet the state water quality standards in situations where it has been established that septic systems contribute to non-attainment.

MODIFIED DEVELOPMENT OF REGIONAL IMPACT REVIEW

The Commission has historically reviewed CWMPs as DRIs pursuant to the Cape Cod Commission Act. In accordance with the Act, in order to approve a DRI, the Commission must find that a proposed project is consistent with any Commission-certified Local Comprehensive Plan (LCP); municipal development bylaws; any District of Critical Planning Concern Implementing Regulations; the Regional Policy Plan; and the probable benefit from a proposed project must be greater than the probable detriment.

The Regional Policy Plan contains over 200 minimum performance standards and best development practices in 12 different issue areas – including land use, economic development, water resources, coastal resources, wetlands, wildlife and plant habitat, open space and recreation, transportation, waste management, energy, affordable housing and heritage preservation/community character. Currently, these MPSs and Best Development Practices (BDPs) are applied during DRI review not only to site-specific individual developments, such as supermarkets and commercial businesses, but also to larger systemic phased projects, such as CWMPs.

The Section 208 Plan Update recognizes the need to modify the existing regulations in order to accommodate the unique nature of wastewater management planning and recommends consideration of alterations to Commission regulations.

The Commission should amend its regulations accommodating for the unique nature of capital wastewater management planning.

Recommendation R3.5: The Cape Cod Commission shall amend its regulations accommodating for the unique nature of capital wastewater management planning.

SPECIAL REVIEW PROCESS

The voluntary Cape Cod Commission/MEPA Joint Review Processed discussed above applies to comprehensive capital planning projects as well as individual parcel developments. CWMPs typically require MEPA review and Commission DRI review and Cape Cod towns have historically elected to participate in the JRP.

Additionally, the Secretary may establish a Special Review Procedure (SRP) for a project that may provide for coordination and consolidation of MEPA review with other environmental or development review and permitting processes (310 CMR 11). An example of an established SRP within Barnstable County is the Herring River Restoration Project in Wellfleet and Truro.

As an alternative to the existing JRP, a Special Review Procedure for Projects designed pursuant to the Section 208 Plan Update should be developed. The SRP should provide a framework for review and implementation of regional wastewater projects and provide flexibility and opportunities for streamlining. Projects could include CWMPs that address nutrient remediation in all watersheds

within a municipality or group of municipalities; Targeted Watershed Management Plans (TWMPs) that address nutrient remediation within a single watershed or a grouping of watersheds, wholly contained within one municipality, or shared by multiple municipalities; and Nutrient Remediation Projects that are individual water quality restoration projects addressing portions of watersheds or municipalities.

A Section 208 Plan Update SRP could contain the following elements:

- **CAPE COD COMMISSION SECTION 208 CONSULTATION:** Municipalities are encouraged to consult with the Commission to ensure coordination between active wastewater planning efforts and the Section 208 Plan Update and to establish consistency between proposed municipal plans and the Section 208 Plan Update with respect to the evaluation of wastewater needs, wastewater management alternatives, and alternatives analyses. Consultation also includes use of Commission decision support tools, such as WatershedMVP, with Commission staff assistance. The Commission would assign a Watershed Team to the specific planning efforts to assist with the decision support tools, permitting of technologies, and financing.
- **WATERSHED ASSOCIATIONS ESTABLISHED:** For projects addressing watersheds shared by more than one town, Watershed Associations could be established. Possible members could include elected and appointed municipal representatives, members of existing water quality advisory committees, representatives from Joint Base Cape Cod or the Cape Cod National Seashore, as appropriate, an expert on traditional wastewater approaches, representatives from the business, real estate and environmental sectors, a Commission representative, and an alternative technology representative. Under current regulations, when establishing a SRP, the Secretary ordinarily establishes a Citizens Advisory Committee (CAC) to assist in reviewing the project. Existing municipal CACs or water quality advisory committees, or a newly formed Watershed Association could be designated as the CAC.
- **WATERSHED MANAGEMENT PLAN DEVELOPED:** Watershed Management Plans should address all water quality planning including remediation of nitrogen, phosphorus, contaminants of emerging concern (CECs), etc. Individual projects identified as CWMPs, TWMPs and other Nutrient Remediation Projects could be eligible for the Section 208 Plan Update SRP. The Project plans should be submitted to MEPA and the Commission simultaneously for expedited review by both entities.
- **PUBLIC HEARING PROCESS:** The citizen engagement process should be expansive and educational and should allow for all public, local, state, regional and federal comment on proposed Projects.
- **FINAL EIR/COMMISSION DRI:** In order to streamline review, a simplified process of submitting one review document that can suffice as a Final EIR and Commission DRI application should be implemented. Upon approval, this document would lead to the Secretary's issuance of a Certificate of Adequacy for the FEIR and the Commission's DRI approval decision.

A recommendation of the Section 208 Plan Update is for the Commission to work with MassDEP and the Secretary of Energy and Environmental Affairs on a Special Review Procedure for Projects designed pursuant to the Section 208 Plan Update, to execute a Memorandum of Understanding between the Cape Cod Commission and the Secretary of Environmental Affairs, and to identify and implement other potential regulatory changes.

Recommendation R3.6: The Cape Cod Commission and MEPA should work together to develop an effective and streamlined process for reviewing projects designed pursuant to the Section 208 Plan Update that are reviewed jointly by both agencies.

SECTION 208 PLAN UPDATE CONSISTENCY REVIEW

A recommendation of this plan is the requirement that all nutrient management planning in the region be subject to review for consistency with the Section 208 Plan Update.

Recommendation R3.7: All nutrient management planning in the region shall be subject to review for consistency with the Section 208 Plan Update.

As outlined below, the consistency review will include, but is not limited to, a review of the planning approach used to ensure consistency with a proposed hybrid watershed planning approach; review and acceptance of a nutrient growth management plan; and a consistency review of the applicable Minimum Performance Standards and Best Management Practices for siting technologies. Specific guidance on the Section 208 Plan Update Consistency Review shall be issued within 90 days of its approval.

Recommendation R3.8: Specific guidance on the Section 208 Plan Update Consistency Review shall be issued by the Cape Cod Commission within 90 days of the 208 Plan Update approval.

Hybrid Watershed Planning Approach

It is recommended that for most watersheds, the most efficient and effective combination of watershed management strategies should include a planning process that integrates prevention, collection, and non-collection strategies. See Chapter 5 for a detailed discussion of the hybrid watershed planning approach.

Review and Acceptance of Nutrient Growth Management Plan

Growth management measures and strategies are an important component in managing nutrient impacts to coastal embayments. As part of the Section 208 Plan Update, the Commission recommends the establishment of a Nutrient Growth Management Plan. A commitment to review and accept or adopt a Nutrient Growth Management Plan shall be a requirement for any watershed plan seeking to realize the benefits related to consistency, and shall be a component of the Section 208 Plan Update Consistency Review. In addition, it is recommended that local plans segregate and present costs to manage nutrient removal from existing development and costs to manage nutrient removal from anticipated new development.

Minimum Performance Standards and Best Management Practices

As part of the Section 208 Plan Update, the Commission recommends MPSs and BMPs for siting technologies should be developed. Compliance with these MPSs and BMPs shall be requirements for any watershed plan seeking to realize certain benefits related to consistency. The MPSs and BMPs shall draw upon updated information in the Technologies Matrix for siting and monitoring technologies and approaches to nutrient management and shall be updated on a regular basis. They will address specific requirements from Section 208 of the Clean Water Act with regard to site selection impacts on water resources and other natural resources, including, but not limited to, impacts from construction and the location of disposal, and their effects on freshwater, saltwater and drinking water resources. Consistency with the MPSs and BMPs shall be a component of the Section 208 Plan Update Consistency Review.

Preserving Capacity for Towns in Shared Watersheds

Where centralized technologies are employed, localities should preserve capacity for treatment and/or disposal by towns in shared watersheds where feasible. Shared systems in higher density areas reduce costs for everyone by bringing more customers online to share costs.

Conducting a Fiscal Analysis of Costs to Taxpayers when Regional Solutions are not Adopted

In the event a municipality determines that it will not pursue available opportunities to design, construct and operate shared infrastructure, they shall conduct and present a fiscal analysis of potential additional costs associated with constructing infrastructure limited to town boundaries.

04 SOLUTIONS

Nutrient Mitigation Technologies & Policies

Cape communities have been aware of decreasing water quality in estuaries and coastal waters for over a decade – but there is little consensus on how to address the problem. Comprehensive wastewater planning at the municipal level is often impeded by concerns about scope and cost, which can lead to failed town meeting votes. The need to identify management options for nutrients beyond traditional collection and centralized treatment approaches became evident. This chapter presents the results of an extensive search for and vetting of alternative approaches for nutrient management on Cape Cod.


Site Scale
Neighborhood
Watershed
Cape-Wide
Reduction
Treatment before disposal to ground
Remediation
Treatment in groundwater
Restoration
Treatment in water body
Title 5
Standard Title 5 Systems
IA
I/A Title 5 Systems
Enhanced IA
I/A Enhanced Systems
Toilets: Composting, Incinerating, Packaging, Urine Diverting
Hydroponic Treatment
Cluster Treatment System: Single- or Two-stage
Satellite Treatment
Nutrient Reducing Development
TDR
Transfer of Development Rights
Conventional Treatment
Advanced
Advanced Treatment
N+P+K MGMT
Fertilizer Management
Compact and Open Space Development
Constructed Wetlands
BMPs
Stormwater Best Managment Practices (BMPs)
Phytoirrigation
PRB
Permeable Reactive Barrier (PRB)
Phytoremediation
Stormwater: Bioretention / Soil Media Filters
N+P
Fertigation Wells: Turf, Cranberry Bogs
Stormwater: Constructed Wetlands
Aquaculture/Shellfish Farming
Coastal Habitat Restoration
Inlet / Culvert Widening
Constructed Wetlands: Floating
Pond and Estuary Circulators
SWR
Surface Water Remediation Wetlands
Pond and Estuary Dredging
Policy

Chapter 4: Nutrient Mitigation Technologies & Policies

Tools for Nutrient Management in Coastal Waters

Cape Codders are closely connected to the water. Whether salt or fresh, water defines Cape Cod and each person's experience with the environment. In the search for solutions to water quality problems, alternative technologies, tools, policies and approaches that may restore water quality in affected water bodies more quickly and cost effectively than traditional methods have been identified. Techniques that may be applied directly within the water body have raised questions about their potential effectiveness, reliability and speed to results.

Water Quality Technologies Matrix

Figure 4.1 (Facing Page)

The technologies and approaches included in the Technologies Matrix address nutrients by means of reduction, remediation, and restoration and are implementable in scales ranging from on-site, to neighborhood, watershed, and Cape-wide.

The Section 208 planning process has provided the opportunity to take an in-depth look at a broad range of techniques for managing nutrients. This chapter examines 10 categories and a total of 67 nutrient reduction, remediation and restoration technologies and approaches. This work is embodied in the Water Quality Technologies Matrix (Technologies Matrix) and then simplified based on the point of intervention, the scale of the technology or approach (site, neighborhood, or watershed) and whether it requires a collection system to remove waste from the property for disposal in another location. The Technologies Matrix includes the breadth of traditional approaches, from on-site (Title 5) systems to centralized treatment facilities, and a diverse array of non-traditional or alternative approaches, ranging from coastal habitat restoration to source-reducing toilets (**Figure 4.1**). The Technologies Matrix is the result of nearly two years of research by Cape Cod Commission staff and consultants, review by a panel of experts, followed by vetting by state, federal, and other stakeholders. **Table 4-1** identifies the technologies and strategies that have been examined.

The Technologies Matrix is conceived as a living compendium of data on nutrient management technologies. The technologies in the Matrix have all shown some promise for being used for nitrogen management; however, many are yet untested on Cape Cod or have been deployed at scales smaller than might be necessary in a watershed plan. It became clear through the research, as well as in questions raised during the many discussions among planning staff, stakeholders, academia and government and private experts, that the Technologies Matrix needs continual refinement as new or more accurate information becomes available through research or from pilot projects on Cape Cod. The actions needed to implement water quality improvements across the Cape will contribute to the body of knowledge about non-traditional nutrient management technologies, allowing us to refine the list of best practices that have proven to be effective in solving water quality problems. It is recommended that the Cape Cod Commission develop a process for annual updates to the Technologies Matrix.

TECHNOLOGY GROUPING	TECHNOLOGY / STRATEGY
Green Infrastructure	Constructed Wetlands - Surface Flow
	Constructed Wetlands - Subsurface Flow
	Constructed Wetlands - Groundwater Treatment
	Hydroponic Treatment
	Phytoirrigation
	Stormwater BMP - Phytobuffers
	Stormwater BMP - Vegetated Swale
	Stormwater BMP - Gravel Wetland
	Stormwater: Bioretention / Soil Media Filters
	Stormwater: Constructed Wetlands
Innovative and Resource-Management Technologies	Aquaculture - Shellfish Cultivated In Estuary Bed
	Aquaculture - Shellfish Cultivated Above Estuary Bed
	Aquaculture - Mariculture
	Phytoremediation
	Permeable Reactive Barriers (PRBs) - Trench Method
	Permeable Reactive Barriers (PRBs) - Injection Well Method
	Fertigation Wells - Turf
	Fertigation Wells - Cranberry Bogs
Waste Reduction Toilets	Toilets: Composting
	Toilets: Incinerating
	Toilets: Packaging
	Toilets: Urine Diverting
Non-Structural Approaches	Fertilizer Management
	Stormwater BMPs
	Nutrient Reducing Development
	Compact and Open Space Development
	Transfer of Development Rights
System Alterations	Inlet / Culvert Widening
	Coastal Habitat Restoration
	Floating Constructed Wetlands
	Pond and Estuary Circulators
	Surface Water Remediation Wetlands
	Chemical Treatment of Ponds
	Pond and Estuary Dredging

TECHNOLOGY GROUPING	TECHNOLOGY / STRATEGY
On-Site Treatment Systems	Title 5 Septic System Replacement (Base Line Condition)
	Innovative/Alternative (I/A) Systems
	Innovative/Alternative (I/A) Enhanced Systems
Treatment Systems	Cluster Treatment System - Single-stage
	Cluster Treatment System - Two-stage
	Conventional Treatment
	Advanced Treatment
	Satellite Treatment
	Satellite Treatment - Enhanced
Collection Systems	Gravity Sewer
	Low Pressure Sewer
	Vacuum Sewer
	Force Main
	Pump Station
	On-Site Pump Station
	STEG - Collection
	STEP - Collection
Effluent Disposal	Effluent Disposal - Infiltration Basins
	Effluent Disposal - Soil Absorption System (SAS)
	Effluent Disposal - Injection Well
	Effluent Disposal - Wick Well
	Effluent Disposal - Ocean Outfall
	Effluent Transport out of Watershed to Recharge, Reuse Facility or Ocean Outfall
Solids Processing	Septage Processing
	Commercial Disposal
	Dewater and Haul to Landfill
	Composting
	Incineration
	Lime Stabilization
	Digestion
	Thermal Drying
	Drying and Gasification

Technologies Included in the Water Quality Technologies Matrix

Table 4-1

Recommendation I4.1: The Cape Cod Commission shall develop a process for annual updates to the Technologies Matrix.

Among the actions needed to validate the efficacy of non-traditional approaches are the piloting of technologies in suitable locations, monitoring water quality and environmental parameters down gradient from a technology, analyzing technology performance and updating the Technologies Matrix as appropriate. Piloting, monitoring and analysis are discussed later in this chapter, along with corresponding recommendations for action. In addition, this plan recommends an annual symposium to present and review new research on these nutrient management techniques. The symposium will support the exchange of research on these tools and provide an opportunity to share experiences on the implementation of pilot projects. New findings may then be incorporated into the Technologies Matrix on a regular basis. A web-based interface will make the data on these technologies available to anyone.

Recommendation I4.2: The Cape Cod Commission shall seek opportunities to sponsor an annual symposium to present and review new research on nutrient management technologies and approaches that coincides with regular updates to the Technologies Matrix.

Catalog of Non-Traditional Technologies

In the pages that follow, summaries of the non-traditional technologies and approaches are presented in an at-a-glance format. This "catalog" of technologies provides a simple method of comparison. Among the features covered in this section are the benefits and performance challenges of a technology, its efficiency in addressing nitrogen, its resilience to sea level rise and whether it rose to the top as a technology for use in developing watershed scenarios on Cape Cod.

Each tool or practice has been categorized according to the scale and the situation in which it best performs. Technologies sorted as restoration are those that address nutrient rich water within an affected water body. Technologies categorized as remediation are those that treat nutrient rich water as it travels through the groundwater, before it reaches a water body. Technologies identified as reduction are those that reduce nitrogen before it enters the groundwater.

As discussed at many of the stakeholder meetings, the Section 208 Plan Update recognizes that while non-traditional technologies hold great promise in managing nutrients in groundwater and water bodies, traditional technologies will also play a significant role in wastewater management. Following the catalog of information presented below, the types and merits of traditional wastewater treatment are reviewed. Traditional wastewater approaches typically do not require piloting to establish performance; consequently, brief summaries of the types of technologies are presented in this chapter to familiarize the reader with the range of methods available.

Detailed performance information may not be available for all technologies at this time. However, a more detailed narrative of each of each technology can be found in Appendix 4A; the most detailed and extensive information can be found in the Technologies Matrix, available in Appendix 4B or on the web at: http://capecodcommission.org/matrix.

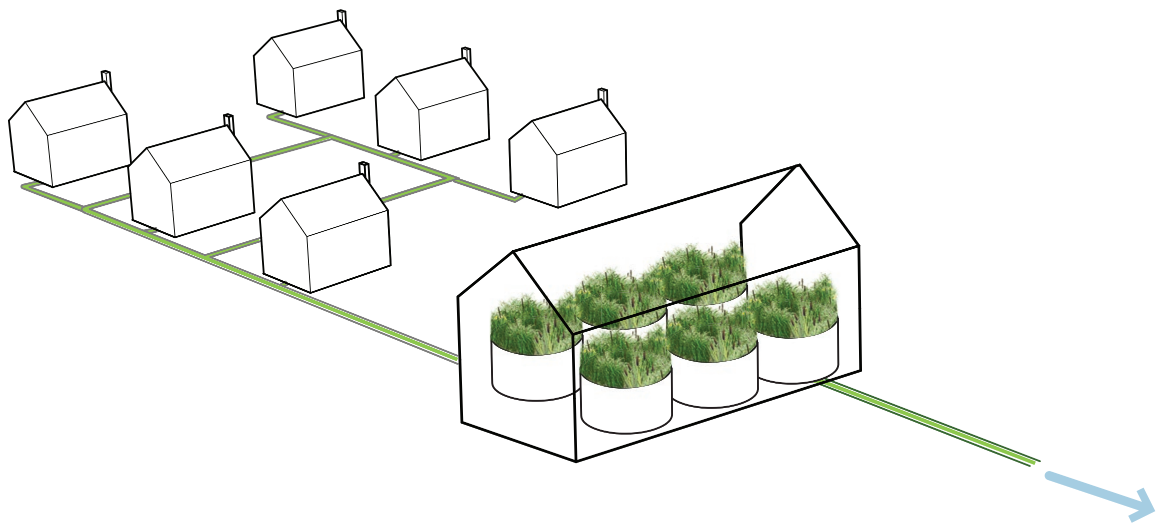


Figure 4-2

Hydroponic Treatment

SCALE: SITE/NEIGHBORHOOD/WATERSHED
APPROACH: REDUCTION

SCENARIO PLANNING: NOT SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

Hydroponic treatment and Photo Bioreactors are natural systems that treat septic tank effluent or primarily treated wastewater. With Hydroponic Treatment, aeration and clarification chambers are combined with constructed wetlands to treat the influent. The wetlands are a series of chambers allowing for microbial communities to engage with and treat the wastewater. Plants are often suspended on racks with their roots systems doing the work. Solids removal is generally onsite, after which water is pumped through the gravel filled cells (similar to subsurface wetlands.) This process transfers more oxygen to the wastewater and completes the pollutant removal process. The wetland effluent can be discharged into a water body or used for open space irrigation after treatment. The wetland effluent can also be discharged into a leach field or similar system for discharge to the groundwater.This technology can also be used for wastewater treatment with primary, secondary, or advanced effluent generally for flows less than 500,00 gpd.

Technology Performance

Nitrogen Removal 58% to 98%

Phosphorus Removal 25% to 75%

$964	$60,136
Removal Cost per kg N (avg life cycle)	Removal Cost per kg P (avg life cycle)
10 years	1 to 10 years
Useful Life	Time to See Results

Hydroponic Treatment

SCALE: SITE/NEIGHBORHOOD/WATERSHED
APPROACH: REDUCTION

SCENARIO PLANNING: NOT SELECTED FOR USE
IDENTIFIED FOR PILOTING

SITING NEEDS

- Adjacent to housing and development

ECO-BENEFITS

- Promotes Green Space / Conservation / Recreation
- Improves Management of Flooding / Extreme Events

PERFORMANCE CHALLENGES

- Require high energy and maintenance costs as these systems are generally constructed in greenhouses
- Low phosphorus removal rates

CLIMATE RESILIENCE: RISKS

- Degradation of materials and reduced asset lifespan due to more frequent inundation and increased exposure to saline water
- Mobilization of contamination as a result of failure of storage system
- Backflow of saline water into system causing overflows, increased degradation of materials and change in biological processes
- Destabilization of assets as a result of changes in groundwater levels or erosion

CLIMATE RESILIENCE: SOLUTIONS

- Locate infrastructure outside the flood hazard area that is anticipated for the life of the installation
- Select materials and coatings that are able to cope with an increasingly saline environment
- Ensure frequent maintenance inspections to monitor asset condition (e.g. rate of corrosion) and performance of technology (i.e. achieving nutrient removal targets)
- Backflow valves on outlets
- Anchoring of buried assets

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Massachusetts Department of Environmental Protection

Fertilizer Management

N+P+K MGMT

SCALE: CAPE WIDE

APPROACH: REDUCTION

SCENARIO PLANNING: SELECTED FOR USE

Figure 4-3

Fertilizer Management

SCALE: CAPE WIDE
APPROACH: REDUCTION

SCENARIO PLANNING: SELECTED FOR USE
N+P+K MGMT

DESCRIPTION

This approach relies on managing fertilizer application rates to lawns, golf courses, athletic facilities and cranberry bogs. Residential lawn loading rates could be reduced on existing developed parcels through an intensive public education/outreach program. This could include a "Cape Cod Lawn" branding program, replacing some turf areas with native vegetation, establishing naturally-vegetated buffer strips on waterfront lots, and reducing application rates. Fertilizer loading rates for new development could be accomplished by reducing lot sizes (cluster development), by restricting lawn sizes and/or by incorporating more naturally-vegetated open space areas. Municipalities could directly reduce fertilizer applications on athletic fields and other properties. Golf courses can significantly reduce nitrogen loading rates by using slow-release fertilizers and reducing application rates in rough areas.Cranberry bog fertilizer exports from the bogs can be reduced using tail water recovery systems. Site-specific assessments are needed to estimate load reductions.

SITING NEEDS

- Fertilizer management does not have specific site requirements.

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Board of Health
- Massachusetts Department of Agricultural Resources

PERFORMANCE CHALLENGES

- Resulting nutrient removal rates are highly dependent on homeowner / landowner behavior and participation in the program
- Site-specific assessments are needed to estimate load reductions

CLIMATE RESILIENCE: RISKS

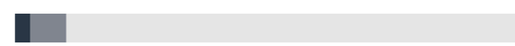
- Fertilizer management does not result in significant climate resiliency risks.

CLIMATE RESILIENCE: SOLUTIONS

- Climate resiliency solutions are not needed for Fertilizer Management.

Technology Performance

Nitrogen Removal 25% to 75%



Phosphorus Removal 3% to 10%

$24
Removal Cost per kg N
(avg life cycle)

$141
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 10 years
Time to See Results

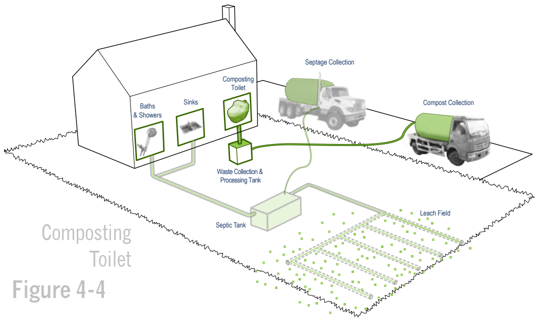
4

REDUCTION

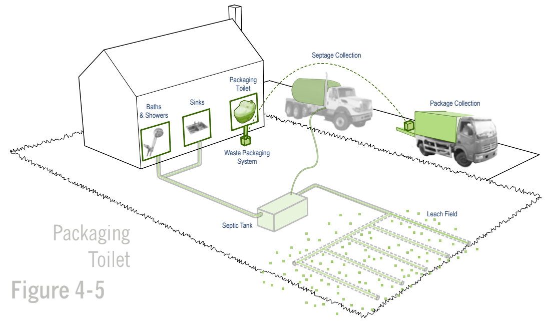
Waste Reduction Toilets

SCALE: SITE
APPROACH: REDUCTION

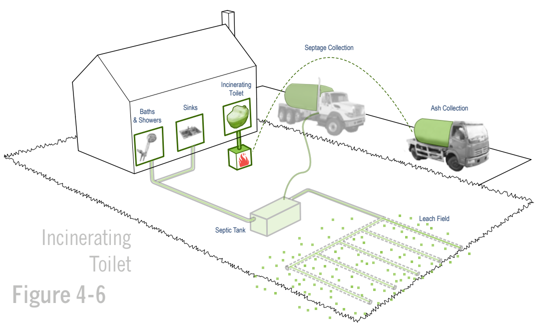
SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING



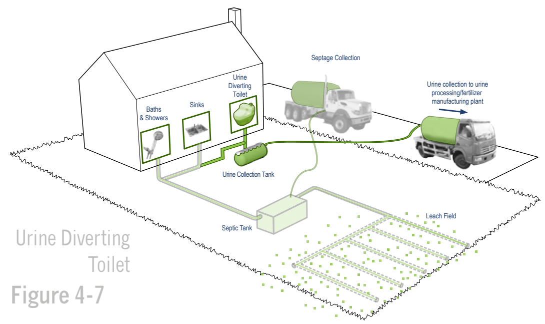
Composting Toilet
Figure 4-4



Packaging Toilet
Figure 4-5



Incinerating Toilet
Figure 4-6



Urine Diverting Toilet
Figure 4-7

DESCRIPTION

A waste reduction toilet is a system which separates human waste from shower, sink and other household water uses. These systems use no or minimal amounts of water. Waste reduction toilets require the installation of a separate toilet(s). Household water uses (i.e. sink and shower uses) continue to flow to the septic system.The four main categories of waste reducing toilets include: composting, incinerating, packaging and urine diverting. Composting toilets capture human waste in a container in the basement where it is decomposed and turned into compost. Incinerating toilets rely on electric power or natural or propane gas to incinerate human waste to sterile, clean ash. Packaging toilets encapsulate human waste in a durable material, stored beneath the toilet, for removal from the site when full. Urine diverting toilets divert urine to a holding tank where it is periodically collected by a servicing company; remaining human waste continues on to the septic system.

SITING NEEDS

- Requires a Title 5 System for ther gray water sources

ECO-BENEFITS

- Improves Energy Savings, Nutrient Recovery, Recycling

PERFORMANCE CHALLENGES

- Resulting nutrient removal rates are highly dependent on homeowner/landowner behavior and participation in the program
- Requires a significant number of citizens to participate to be effective

CLIMATE RESILIENCE: RISKS

- Degradation of materials and reduced asset lifespan due to increased exposure to saline water
- Mobilization of contamination as a result of failure of storage system
- Backflow of saline water into system causing overflows, increased degradation of materials and change in biological processes
- Reduced effectiveness of biological processes as a result of more frequent inundation or exposure to saline water (surface or ground water)
- Temporary restricted access to infrastructure to remove waste materials and undertake maintenance. Longer term access restriction may lead to reduced performance or overflow

Waste Reduction Toilets

SCALE: SITE
APPROACH: REDUCTION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

CLIMATE RESILIENCE: SOLUTIONS

- Select materials and coatings that are able to cope with an increasingly saline environment
- Ensure frequent maintenance inspections to monitor asset condition (e.g. rate of corrosion) and performance of technology (i.e. achieving nutrient removal targets)
- Backflow valves on system
- Anchoring of buried assets

Composting Toilet

Nitrogen Removal 70% to 80%

Phosphorus Removal 25% to 50%

$266
Removal Cost per kg N
(avg life cycle)

$2,323
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 10 years
Time to See Results

SPECIFIC PERFORMANCE CHALLENGES

- Requires ongoing maintenance to function correctly
- Requires independent citizens to change systems to be cost effective

Incinerating Toilet

Nitrogen Removal 70% to 80%

Phosphorus Removal 85% to 95%

$328
Removal Cost per kg N
(avg life cycle)

$1,195
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 10 years
Time to See Results

SPECIFIC PERFORMANCE CHALLENGES

- Incineration process demolishes any nutrients found in human waste - meaning it cannot be used for nourishing soil
- Saves water, but uses more energy
- Still requires septic tank and leaching field for grey water
- The proprietary nature of this technology will impose high fees for waste removal and maintenance

Packaging Toilet

Nitrogen Removal 70% to 80%

Phosphorus Removal 85% to 95%

$198
Removal Cost per kg N
(avg life cycle)

$720
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 10 years
Time to See Results

SPECIFIC PERFORMANCE CHALLENGES

- Still requires septic tank and leaching field for grey water
- The proprietary nature of this technology will impose high fees for waste removal and maintenance

Urine Diverting Toilet

Nitrogen Removal 40% to 60%

Phosphorus Removal 25% to 50%

$333
Removal Cost per kg N
(avg life cycle)

$2,912
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 10 years
Time to See Results

SPECIFIC PERFORMANCE CHALLENGES

- Requires company infrastructure to pick up package
- Tight tank for urine storage required.

SPECIFIC POTENTIAL PERMITTING AUTHORITIES

- Municipality (Local plumbing inspector)
- Municipal Board of Health

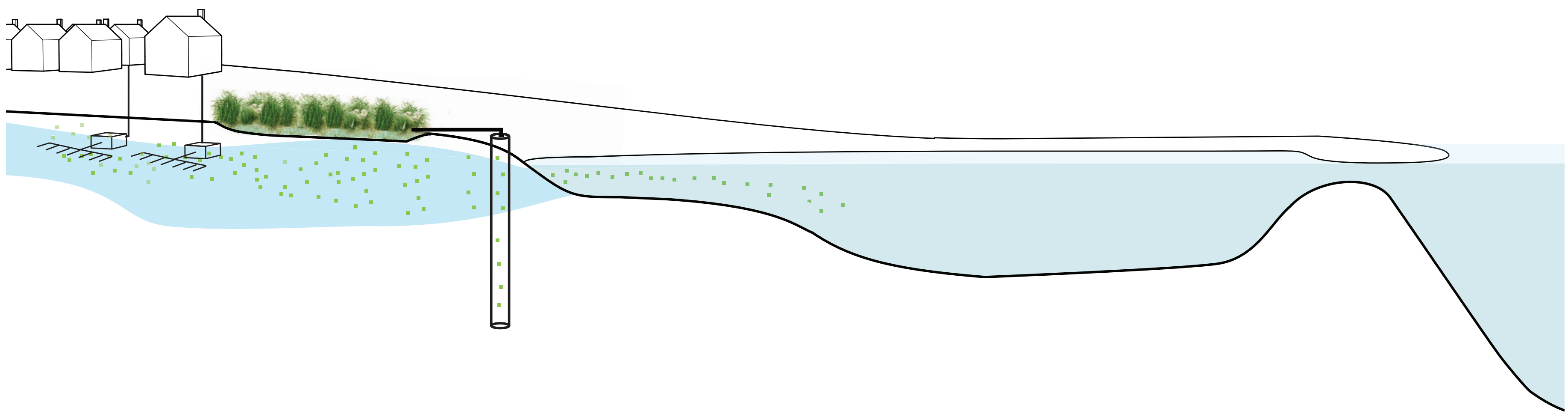


Figure 4-8

Constructed Wetlands Groundwater Treatment

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

After collecting groundwater with higher nitrogen concentrations, groundwater is treated by pumping water slowly through subsurface gravel beds where it is filtered through plant root zones and soil media. Water flows 3" to 8" under the surface to prevent public exposure to wastewater and mosquito breeding. A combination of horizontal and vertical flow subsurface systems must be utilized to provide total nitrogen removal. These systems occasionally use additional treatment steps to remove nutrients from wastewater. The preferred disposal method is an infiltrator chamber system similar to a leach field but larger in size and designed for overflows. The reclaimed water is generally then discharged to the groundwater. The reclaimed water can also be discharged into a water body or used for open space irrigation after treatment. However, more strict permitting and water quality standards must be met if not discharging to groundwater.

Technology Performance

Nitrogen Removal 85% to 95%

Phosphorus Removal 50% to 90%

$340
Removal Cost per kg N
(avg life cycle)

$437
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 10 years
Time to See Results

Constructed Wetlands Groundwater Treatment

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

SITING NEEDS

- Undeveloped land > 1 Acre
- Outside all wetlands resource areas
- Outside 100 year flood hazard zone
- Groundwater separation - GW depth > 4 feet
- Not within priority habitat areas
- Not within protected open space
- Benefit if site has clay based soils, has disturbed soils, parcel intersects with 50 to 100 foot Buffer zone, has municipal ownership
- No steep topography

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Energy Savings / Nutrient Recovery / Recycling
- Improves Management of Flooding / Extreme Events

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection

PERFORMANCE CHALLENGES

- Higher maintenance in first few years
- May require carbon source initially
- Can become clogged over time
- Phosphorous removal may decline over time
- May require fencing and security measures
- May attract water fowl which could aggravate N issue
- In addition, on the Cape, these systems may need to be lined to prevent complete infiltration and allow time for N removal rather than just putting N into groundwater

CLIMATE RESILIENCE: RISKS

- Degradation of materials and reduced asset lifespan due to more frequent inundation and increased exposure to saline water
- Mobilization of contamination as a result of failure of storage system
- Backflow of saline water into system causing overflows, increased degradation of materials and change in biological processes
- Destabilization of assets as a result of changes in groundwater levels or erosion
- Reduced effectiveness of biological processes as a result of more frequent inundation or exposure to saline water (surface or ground water)

CLIMATE RESILIENCE: SOLUTIONS

- Locate infrastructure outside the flood hazard area that is anticipated for the life of the installation
- Select materials and coatings that are able to cope with an increasingly saline environment
- Ensure frequent maintenance inspections to monitor asset condition (e.g. rate of corrosion) and performance of technology (i.e. achieving nutrient removal targets and health of vegetation)
- Backflow valves on outlets
- Anchoring of buried assets
- Project design and species selection to ensure adequate performance in increasingly saline environments

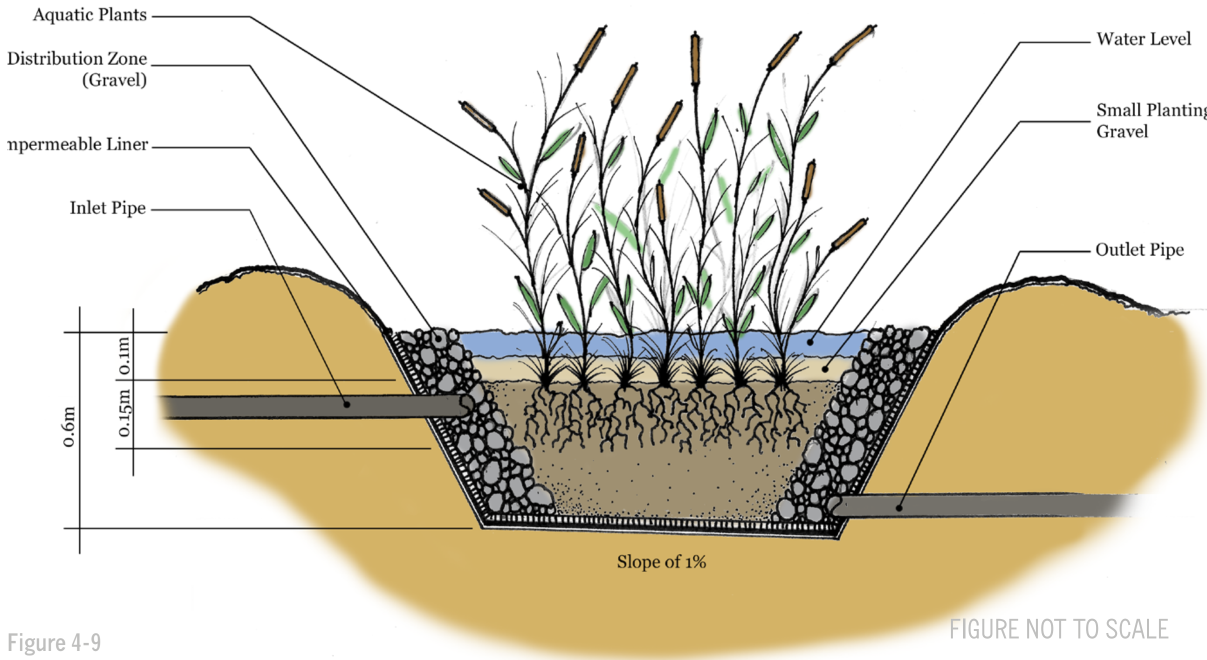


Figure 4-9

Constructed Wetlands Subsurface Flow

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

After primary treatment in a septic tank or WWTF or secondary treatment at a WWTF, wastewater is treated by pumping water slowly through subsurface gravel beds where it is filtered through plant root zones and soil media. Water flows 3-8" under the surface to prevent public exposure to wastewater and mosquito breeding. A combination of horizontal and vertical flow subsurface systems must be utilized to provide total nitrogen removal. The reclaimed water is generally discharged into a leach field or similar system for discharge to the groundwater. The reclaimed water can also be discharged into a water body or used for open space irrigation after treatment. However, more strict permitting and water quality standards must be met if not discharging to groundwater. This technology can be used as an alternative to conventional polishing (i.e. mechanical and/or chemical) of secondary and advanced wastewater treatment.

Technology Performance

Nitrogen Removal 85% to 95%

Phosphorus Removal 50% to 90%

$76
Removal Cost per kg N
(avg life cycle)

$491
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 10 years
Time to See Results

Constructed Wetlands Subsurface Flow

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

SITING NEEDS

- Undeveloped land > 0.5 Acre
- Outside all wetlands resource areas
- Outside 100 year flood hazard zone
- Groundwater separation - GW depth > 4 feet
- Not within priority habitat areas
- Not within protected open space
- Benefit if site has clay based soils, has disturbed soils, parcel intersects with 50 to 100 foot Buffer zone, has municipal ownership
- No steep topography

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Energy Savings / Nutrient Recovery / Recycling
- Improves Management of Flooding / Extreme Events

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection

PERFORMANCE CHALLENGES

- Higher maintenance in first few years
- May require carbon source initially
- Can become clogged over time.
- Phosphorous removal may decline over time
- May require fencing and security measures
- May attract water fowl which could aggravate N issue
- In addition, on the Cape, these systems may need to be lined to prevent complete infiltration and allow time for N removal rather than just putting N into groundwater

CLIMATE RESILIENCE: RISKS

- Degradation of materials and reduced asset lifespan due to more frequent inundation and increased exposure to saline water
- Mobilization of contamination as a result of failure of storage system
- Backflow of saline water into system causing overflows, increased degradation of materials and change in biological processes
- Destabilization of assets as a result of changes in groundwater levels or erosion
- Reduced effectiveness of biological processes as a result of more frequent inundation or exposure to saline water (surface or ground water)

CLIMATE RESILIENCE: SOLUTIONS

- Locate infrastructure outside the flood hazard area that is anticipated for the life of the installation
- Select materials and coatings that are able to cope with an increasingly saline environment
- Ensure frequent maintenance inspections to monitor asset condition (e.g. rate of corrosion) and performance of technology (i.e. achieving nutrient removal targets and health of vegetation)
- Backflow valves on outlets
- Anchoring of buried assets
- Project design and species selection to ensure adequate performance in increasingly saline environments

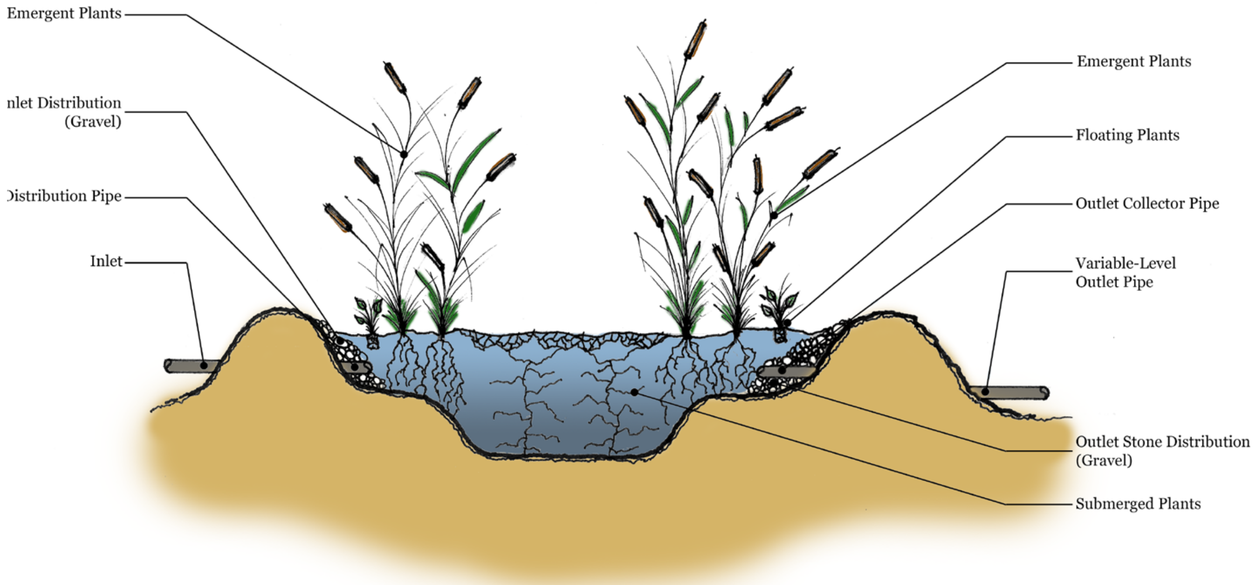


FIGURE NOT TO SCALE

Figure 4-10

Constructed Wetlands Surface Flow

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

After primary treatment in a septic tank or WWTF or secondary treatment at a WWTF, water is fed into a free water surface (FWS) constructed wetland. Free water constructed wetlands closely mimic the ecosystem of a natural wetland by utilizing water loving plants to filter wastewater through their root zone, a planted medium, and open water zones. FWS wetlands are systems where open water is exposed much like in a natural marsh. The reclaimed water is generally discharged into a leach field or similar system for discharge to the groundwater. The reclaimed water can also be discharged into a water body or used for open space irrigation after treatment. However, more strict permitting and water quality standards must be met if not discharging to groundwater. This technology can be used as an alternative to conventional polishing (i.e. mechanical and/or chemical) of secondary and advanced wastewater treatment.

Technology Performance

Nitrogen Removal 80% to 95%

Phosphorus Removal 40% to 60%

$81
Removal Cost per kg N
(avg life cycle)

$709
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 10 years
Time to See Results

Constructed Wetlands Surface Flow

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

SITING NEEDS

- Undeveloped land > 5 Acre
- Outside all wetlands resource areas
- Outside 100 year flood hazard zone
- Groundwater separation - GW depth > 4 feet
- Not within priority habitat areas
- Not within protected open space
- Benefit if site has clay based soils, has disturbed soils, parcel intersects with 50 to 100 foot Buffer zone, has municipal ownership
- No steep topography

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Energy Savings / Nutrient Recovery / Recycling
- Improves management of Flooding / Extreme Events

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection
- U.S. Environmental Protection Agency

PERFORMANCE CHALLENGES

- Requires larger land area than tertiary treatment
- Disinfection of wetland influent may be required
- May require an NPDES permit
- May require a pilot study, long-term monitoring and reporting
- Vegetation harvesting may need to be performed periodically
- May require fencing and security measures
- May attract water fowl which could worsen N issue
- These systems on the Cape may need to be lined to prevent complete infiltration and allow time for N removal rather than just putting N into groundwater
- May need storage of effluent during non-growing season

CLIMATE RESILIENCE: RISKS

- Degradation of materials and reduced asset lifespan due to more frequent inundation and increased exposure to saline water
- Mobilization of contamination as a result of failure of storage system
- Backflow of saline water into system causing overflows, increased degradation of materials and change in biological processes
- Destabilization of assets as a result of changes in groundwater levels or erosion
- Reduced effectiveness of biological processes as a result of more frequent inundation or exposure to saline water (surface or ground water)

CLIMATE RESILIENCE: SOLUTIONS

- Locate infrastructure outside the flood hazard area that is anticipated for the life of the installation
- Select materials and coatings that are able to cope with an increasingly saline environment
- Ensure frequent maintenance inspections to monitor asset condition (e.g. rate of corrosion) and performance of technology (i.e. achieving nutrient removal targets and health of vegetation)
- Backflow valves on outlets
- Anchoring of buried assets
- Project design and species selection to ensure adequate performance in increasingly saline environments

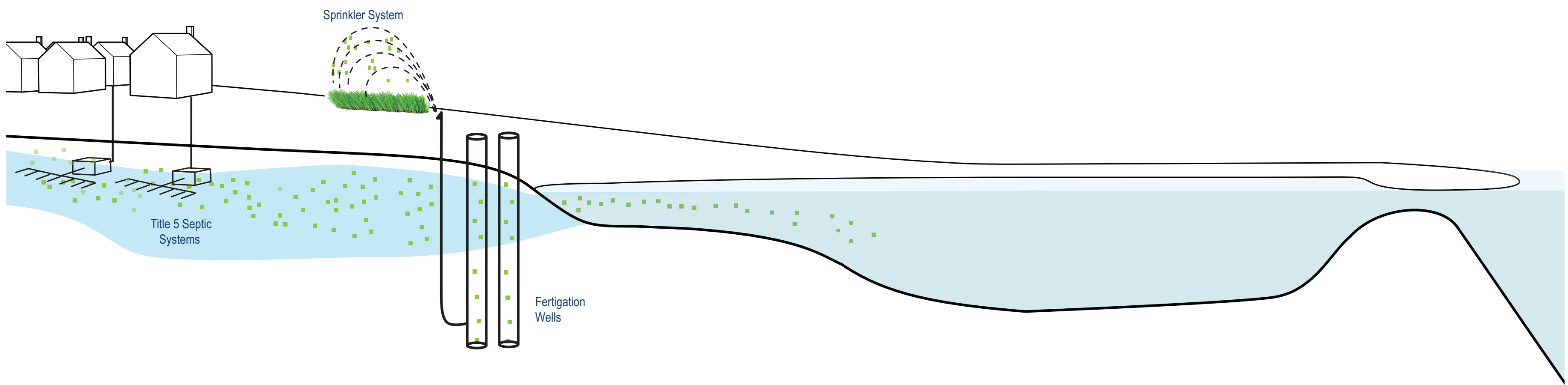


Figure 4-11

Fertigation Wells

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

Fertigation consists of capturing nitrogen enriched groundwater via wells and using it to irrigate plants that use the nutrients. Fertigation wells can capture nutrient enriched groundwater and recycle it back to irrigate and fertilize turf grass areas, and to irrigate crops. Irrigated turf grass areas include golf courses, athletic fields and lawns, while irrigated crops typically include cranberry bogs. Fertigation can reduce nutrient loads to down gradient surface waters while reducing fertilizer costs to the irrigated areas.

Technology Performance

Nitrogen Removal 60% to 80%

Phosphorus Removal 60% to 80%

Removal Cost per kg N (avg life cycle)	Removal Cost per kg P (avg life cycle)
Turf: $151	Turf: $907
Cranberry Bogs: $132	Cranberry Bogs: $795

20 years Useful Life

1 to 10 years Time to See Results

Fertigation Wells

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

SITING NEEDS

- Fertigation wells should be located down gradient of nutrient source areas such as wastewater treatment plant disposal fields and compact development
- They can also be positioned down gradient of high-density subdivisions where they might capture nutrients derived from both septic systems and residential lawns
- The specific locations, depths and diameters can be optimized using standard hydrogeologic principles

ECO-BENEFITS

- Promotes Green Space / Conservation / Recreation
- Improves Energy Savings / Nutrient Recovery / Recycling

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Turf: Massachusetts Department of Environmental Protection
- Cranberry Bogs: Massachusetts Department of Environmental Protection and Municipal Conservation Commission

PERFORMANCE CHALLENGES

- Seasonal technology potentially requiring several capture wells to capture entire nutrient plume
- Most effective in areas where groundwater contains a "plume" of high concentration of nutrients (i.e. down gradient of a WWTF discharge, etc.)
- Need an area to irrigate for nutrient uptake
- May require monitoring

CLIMATE RESILIENCE: RISKS

- Degradation of materials and reduced asset lifespan due to more frequent inundation and increased exposure to saline water
- Inundation leading to saltwater intrusion into groundwater potentially affecting reuse of water (e.g. irrigation)
- Destabilization of assets as a result of changes in groundwater levels or erosion

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor asset condition (e.g. rate of corrosion) and performance of technology (i.e. achieving nutrient removal targets)
- Select materials and coatings that are able to cope with an increasingly saline environment
- Backflow valves on outlets
- Anchoring of buried assets
- Locate technology outside flood hazard area anticipated for the life of the installation

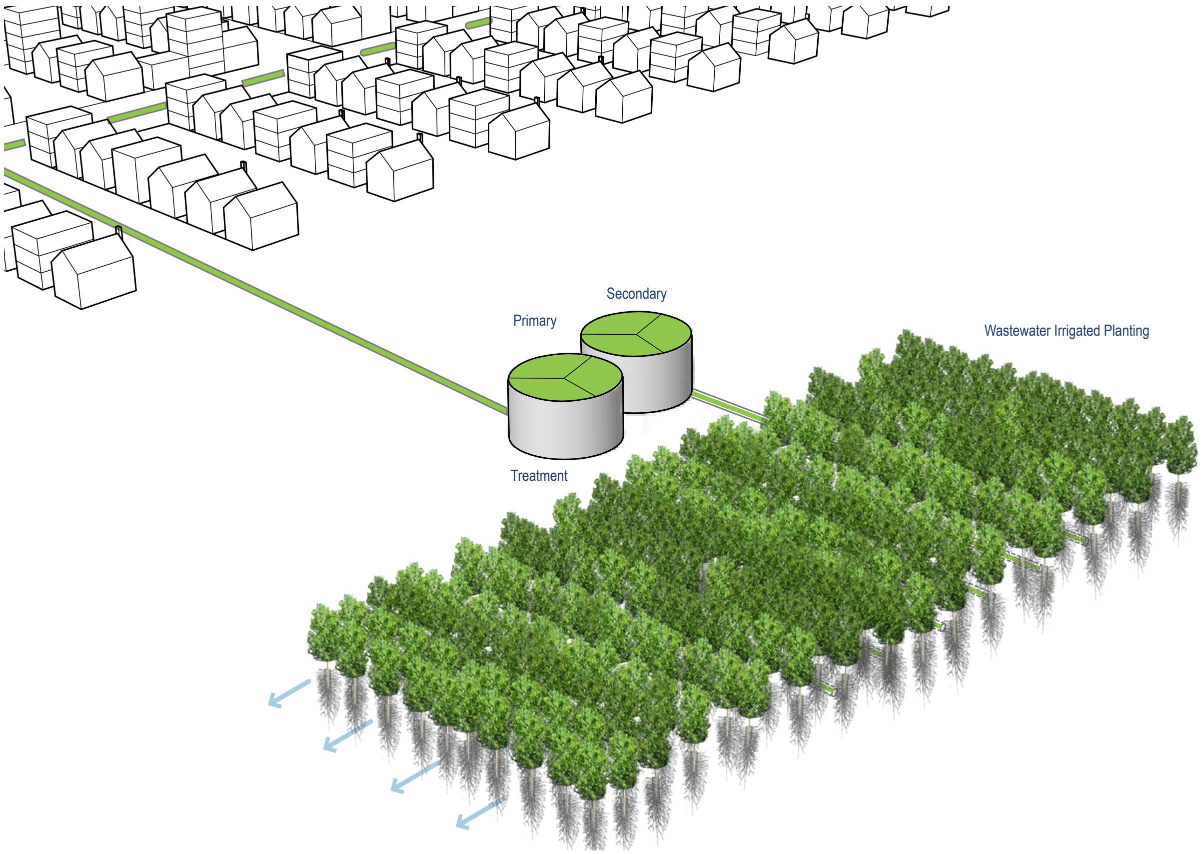


Figure 4-12

Phytoirrigation

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

After secondary treatment, WWTF effluent is irrigated onto plants to remove nutrients and other contaminants. Fast growing poplar and willow trees are typically used. Phytoirrigation requires periodic maintenance and removal of the vegetation being irrigated.

Technology Performance

Nitrogen Removal 50% to 75%

Phosphorus Removal 50% to 75%

$1,899
Removal Cost per kg N
(avg life cycle)

$14,243
Removal Cost per kg P
(avg life cycle)

10 years
Useful Life

1 to 10 years
Time to See Results

Phytoirrigation

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

SITING NEEDS

- Undeveloped open land > 1 acre
- GW depth > 4 feet
- Permeable soils
- Outside all wetlands resource areas
- Outside 100 year flood hazard zone

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Energy Savings / Nutrient Recovery / Recycling
- Improves Management of Flooding / Extreme Events

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection

PERFORMANCE CHALLENGES

- Will likely require meeting stringent and costly water reuse regulations including increased treatment and monitoring requirements
- Plants can only be irrigated during growing season (about 3 months)
- For tree systems, it takes several years before plants are mature enough to uptake the maximum number of gallons per day requiring the effluent be held in holding ponds until the irrigation season

CLIMATE RESILIENCE: RISKS

- Degradation of materials and reduced asset lifespan due to more frequent inundation and increased exposure to saline water
- Mobilization of contamination as a result of failure of storage system
- Backflow of saline water into system causing overflows, increased degradation of materials and change in biological processes
- Destabilization of assets as a result of changes in groundwater levels or erosion
- Reduced effectiveness of biological processes as a result of more frequent inundation or exposure to saline water (surface or ground water)

CLIMATE RESILIENCE: SOLUTIONS

- Locate infrastructure outside the flood hazard area that is anticipated for the life of the installation
- Select materials and coatings that are able to cope with an increasingly saline environment
- Ensure frequent maintenance inspections to monitor asset condition (e.g. rate of corrosion) and performance of technology (i.e. achieving nutrient removal targets and health of vegetation)
- Backflow valves on outlets
- Anchoring of buried assets
- Project design and species selection to ensure adequate performance in increasingly saline environments

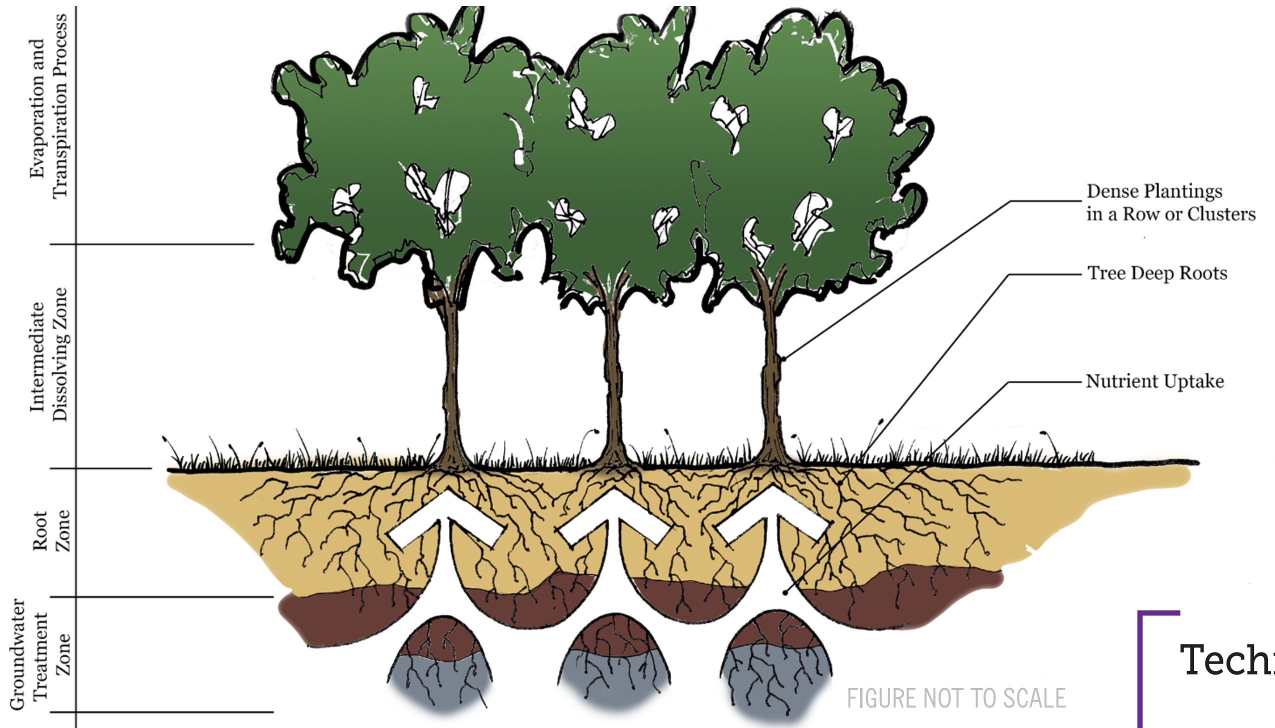


Figure 4-13

Phytoremediation

SCALE: SITE/NEIGHBORHOOD
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

Green plants with deep tap roots are planted as a buffer to intercept high nitrogen (nitrogen enriched) groundwater. The plants and microorganisms in their root zone reduce/use the nitrogen, removing it from the groundwater and watershed. Phytoremediation can be used to redirect a plume of nitrogen enriched groundwater or pull it up from deeper in the aquifer, allowing the plants to treat the plume.

Technology Performance

Nitrogen Removal 50% to 90%

Phosphorus Removal 20% to 60%

$228
Removal Cost per kg N
(avg life cycle)

$1,999
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 10 years
Time to See Results

Phytoremediation

SCALE: SITE/NEIGHBORHOOD
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

SITING NEEDS

- Permeable soils
- Depth to groundwater <10 feet
- Not within priority habitat areas
- Not within protected open space
- Benefit if site is located within a Zone II, has disturbed soils, parcel intersects with 50 to 100 foot wetland buffers, has municipal ownership, necessary nitrogen removal in groundwater filtering through parcel is high

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Energy Savings / Nutrient Recovery / Recycling
- Improves Management of Flooding / Extreme Events

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Licensed Site Professional/Massachusetts Department of Environmental Protection
- U.S. Environmental Protection Agency

PERFORMANCE CHALLENGES

- In year one after planting, no remediation occurs because trees have not reached the groundwater. As the trees get larger and pump more water, nitrogen removal rates increase and plateau
- Plants can only be irrigated during the growing season, requiring use of holding ponds in non-growing season.

CLIMATE RESILIENCE: RISKS

- Reduced effectiveness of biological processes as a result of more frequent inundation or exposure to saline water (surface or ground water)

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor condition and performance of technology (i.e. achieving nutrient removal targets and health of vegetation)
- Species selection to ensure adequate performance in increasingly saline environments
- Preserve areas / buffers to allow migration of salt marsh to higher elevations as MHW rises

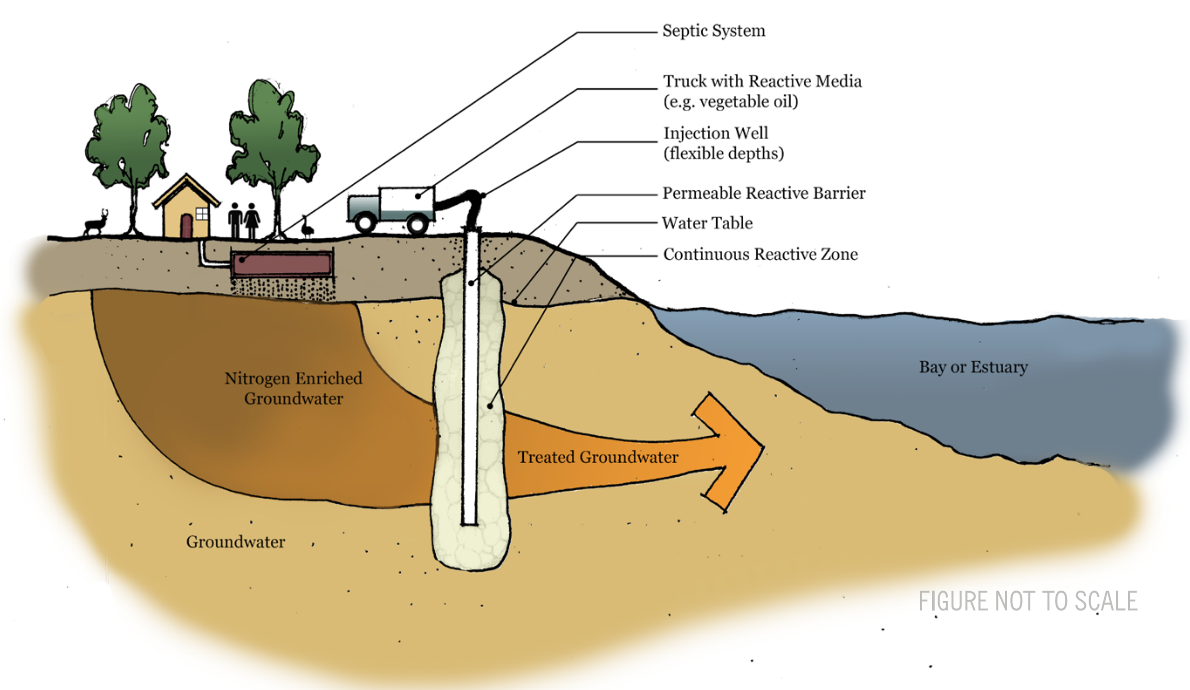


Figure 4-14

Permeable Reactive Barriers (PRBs) Injection Well Method

PRB

SCALE: SITE/NEIGHBORHOOD
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

A permeable reactive barrier (PRB) is an in-situ (installed within the aquifer) treatment zone designed to intercept nitrogen enriched groundwater. Through use of a carbon source, microbes in the groundwater uptake the nitrogen, denitrifying the groundwater. An injection Well PRB system typically uses a series of injection wells to introduce the carbon source (medium) into the groundwater.The injection wells can be installed to depth greater than the PRB trench method. The injection well PRB method can be used in combination with the PRB trenching method described previously. As groundwater flows through the medium, microbes naturally occurring in the groundwater consume the carbon source, as well as oxygen, developing an anaerobic environment. This process releases nitrogen gas to the atmosphere, reducing the groundwater nitrogen load before reaching the estuary.

Technology Performance

Nitrogen Removal 75% to 95%

Phosphorus Removal 50% to 95%

$279	$1,310
Removal Cost per kg N (avg life cycle)	Removal Cost per kg P (avg life cycle)
20 years	1 to 10 years
Useful Life	Time to See Results

Permeable Reactive Barriers (PRBs) Injection Well Method

SCALE: SITE/NEIGHBORHOOD
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

PRB

SITING NEEDS

- Suitable groundwater flow path (depth to intercept groundwater)
- Generally at least 20 feet of saturated aquifer thickness is desired
- In general, the injection well PRB can be installing areas with steeper topography than a trench PRB
- In general, the injection well PRB can be installing areas where utilities limit the installation of trench PRBs
- Ready access for construction
- Access to sites up gradient or down gradient to allow groundwater monitoring
- Permitting requirements if used in or near wetlands
- Construction cost based on 20-foot spacing between injection wells installed to an overall depth of 40 feet. Deeper installations are possible

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Massachusetts Department of Environmental Protection

ECO-BENEFITS

- Improves Energy Savings / Nutrient Recovery / Recycling
- Improves Management of Flooding / Extreme Events

PERFORMANCE CHALLENGES

- Siting can be limited by wetlands, public utilities and abutter concerns
- Detailed knowledge of local groundwater hydrology needed
- Large projects may require a hydrogeologic investigation and groundwater modeling to estimate effectiveness of PRB
- Permitting requirements may be extensive and time consuming
- Projects may require extensive groundwater monitoring early in the project to quantify nitrogen load reduction
- Projects may require groundwater monitoring near or in embayments as well as monitoring of vegetation and benthic monitoring where groundwater surfaces in the receiving estuary

CLIMATE RESILIENCE: RISKS

- Degradation of materials and reduced asset lifespan due to more frequent inundation and increased exposure to saline water
- Inundation leading to saltwater intrusion into groundwater potentially affecting reuse of water (e.g. irrigation)
- Destabilization of assets as a result of changes in groundwater levels or erosion

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor asset condition (e.g. rate of corrosion) and performance of technology (i.e. achieving nutrient removal targets)
- Select materials and coatings that are able to cope with an increasingly saline environment
- Backflow valves on outlets
- Anchoring of buried assets
- Locate technology outside flood hazard area anticipated for the life of the installation

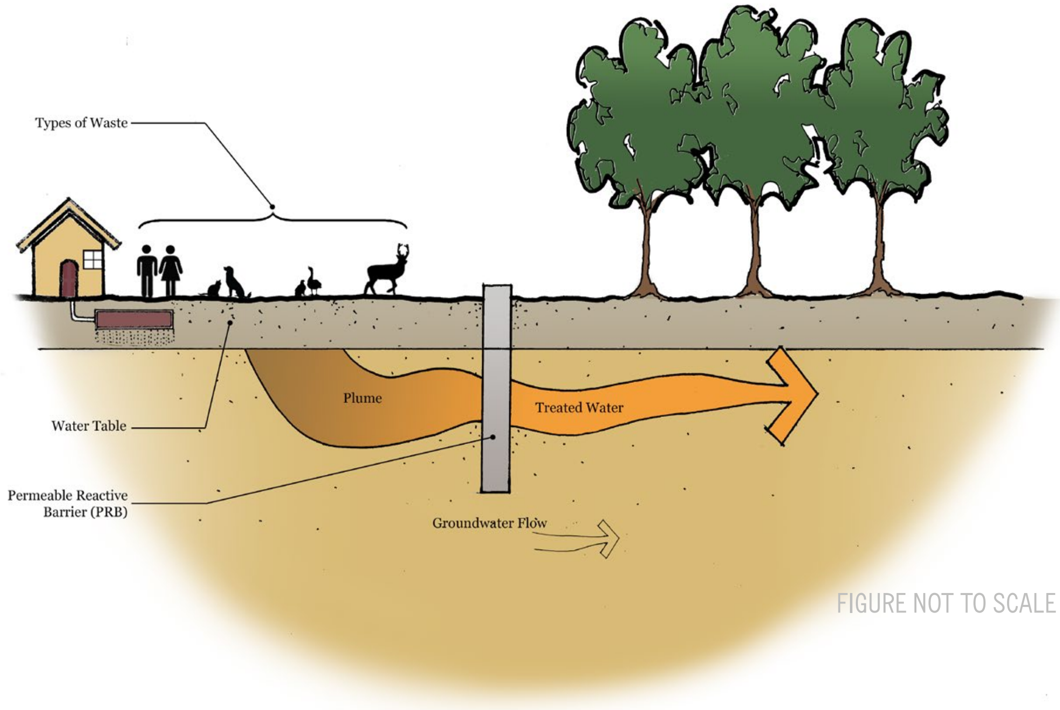


Figure 4-15

Permeable Reactive Barriers (PRBs) Trench Method

PRB

SCALE: SITE/NEIGHBORHOOD
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

A permeable reactive barrier (PRB) is an in-situ (installed within the aquifer) treatment zone designed to intercept nitrogen enriched groundwater. Through use of a carbon source (the PRB medium), microbes in the groundwater uptake the nitrogen, denitrifying the groundwater. The trench method PRB uses large trenching equipment to install a mixture of coarse sand, wood chips, compost and/or other materials (medium) in the trench created by the trencher. The vertical wall can be installed to a depth of 40 feet with a width of 1.5 to 3 feet; PRBs can also be installed in large diameter columns. As groundwater flows through the wall, the medium provides a carbon source for microbes living in the groundwater. The microbes consume the carbon source as well as oxygen, developing an anaerobic environment which releases nitrogen gas to the atmosphere, reducing the groundwater nitrogen load before reaching the estuary.

Technology Performance

Nitrogen Removal 75% to 95%

Phosphorus Removal 50% to 95%

$158
Removal Cost per kg N
(avg life cycle)

$743
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 10 years
Time to See Results

Permeable Reactive Barriers (PRBs) Trench Method

SCALE: SITE/NEIGHBORHOOD
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

PRB

SITING NEEDS

- Suitable groundwater flow path (depth to intercept groundwater)
- Generally at least 20 feet of saturated aquifer thickness is desired
- Relatively level site
- Ready access for construction
- Access to sites up gradient or down gradient to allow groundwater monitoring
- Limited vegetation, Limited public utilities
- Permitting requirements if used in or near wetlands
- Construction cost based on width of 3 feet width, and an overall depth of 40 feet (using existing trenching equipment - deeper in installations are possible using injection well PRBs described below)

ECO-BENEFITS

- Improves Energy Savings / Nutrient Recovery / Recycling
- Improves Management of Flooding / Extreme Events

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Massachusetts Department of Environmental Protection

PERFORMANCE CHALLENGES

- Siting can be limited by wetlands, public utilities and abutter concerns
- Detailed knowledge of local groundwater hydrology needed
- Projects may require a hydrogeologic investigation and groundwater modeling to estimate effectiveness of PRB
- Permitting requirements may be extensive and time consuming
- Projects may require extensive groundwater monitoring early in the project to quantify nitrogen load reduction
- Projects may require groundwater monitoring near or in embayments as well as monitoring of vegetation and benthic monitoring where groundwater surfaces in the receiving estuary

CLIMATE RESILIENCE: RISKS

- Degradation of materials and reduced asset lifespan due to more frequent inundation and increased exposure to saline water
- Inundation leading to saltwater intrusion into groundwater potentially affecting reuse of water (e.g. irrigation)
- Destabilization of assets as a result of changes in groundwater levels or erosion

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor asset condition (e.g. rate of corrosion) and performance of technology (i.e. achieving nutrient removal targets)
- Select materials and coatings that are able to cope with an increasingly saline environment
- Backflow valves on outlets
- Anchoring of buried assets
- Locate technology outside flood hazard area anticipated for the life of the installation

Stormwater BMPs

SCALE: CAPE WIDE

APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE

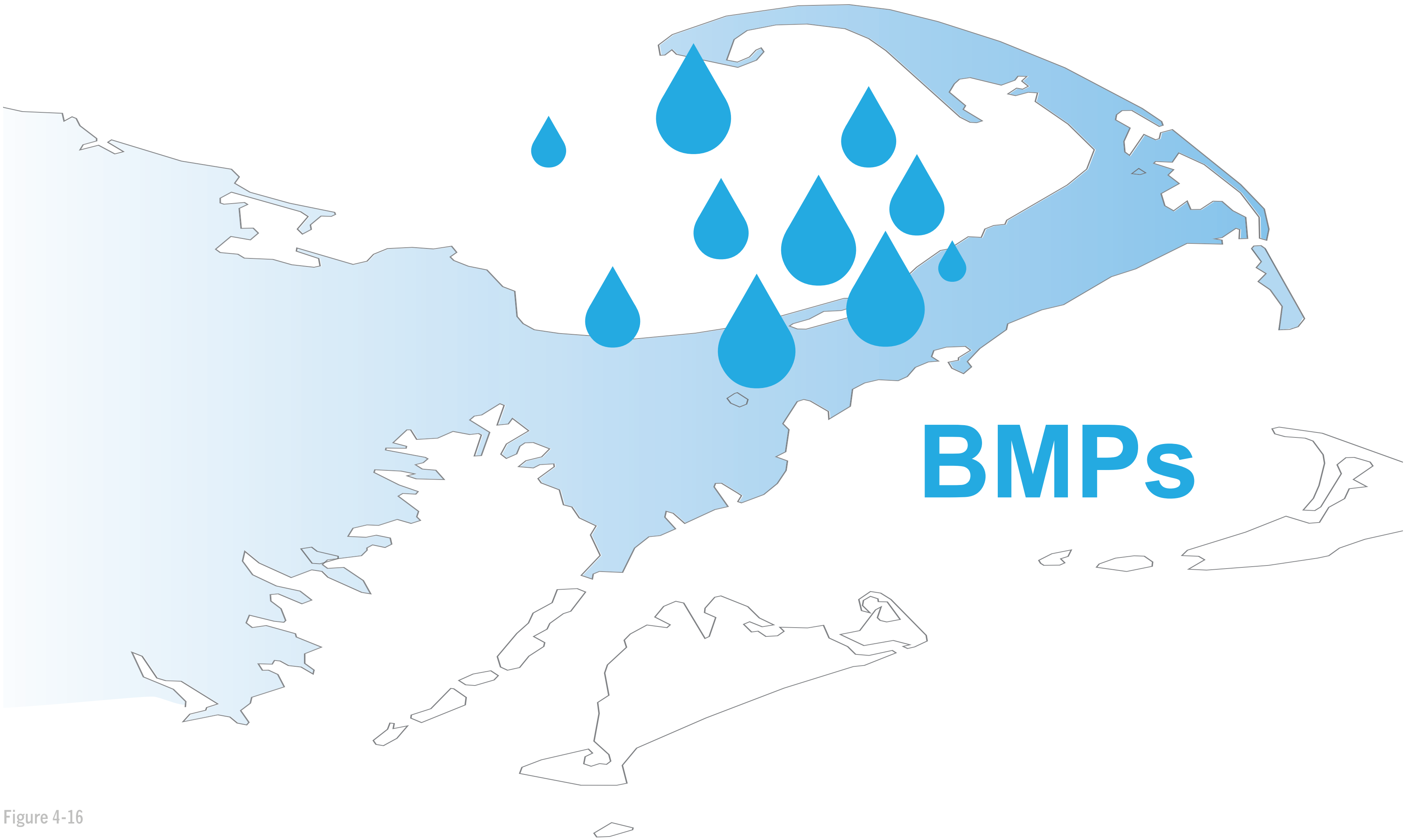


Figure 4-16

Stormwater BMPs

SCALE: CAPE WIDE
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE

BMPs

DESCRIPTION

Non-Structural Stormwater strategies. These strategies include street sweeping, maintenance of stormwater utilities, education and public outreach programs, land use planning, and IC reduction and control.

SITING NEEDS

- Varies

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Management of Flooding / Extreme Events

PERFORMANCE CHALLENGES

- Requires the creation and enforce of stormwater regulations and policies

CLIMATE RESILIENCE: RISKS

- Reduced effectiveness of biological processes as a result of more frequent inundation or exposure to saline water (surface or ground water

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor condition and performance of technology (e.g. achieving nutrient removal targets, health of vegetation)
- Project design and species selection to ensure adequate performance in increasingly saline environments

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection

Technology Performance

Nitrogen Removal 25% to 75%

Phosphorus Removal 1% to 8%

$695
Removal Cost per kg N
(avg life cycle)

$51,470
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 10 years
Time to See Results

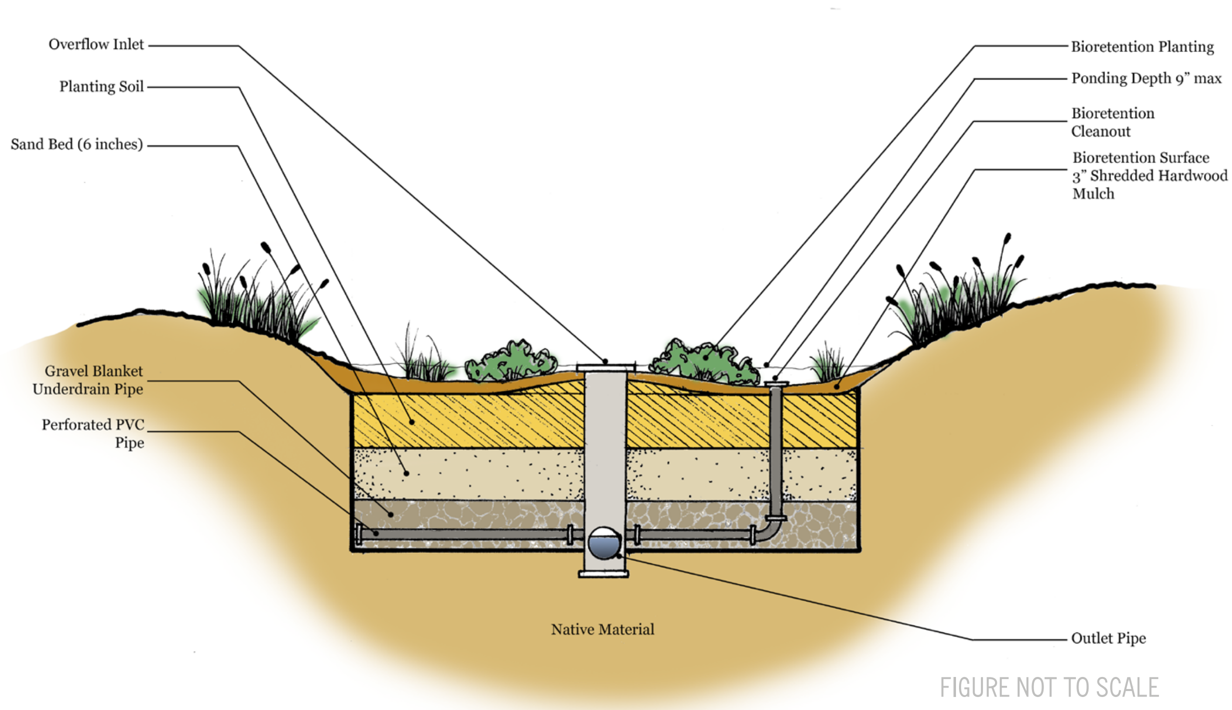


FIGURE NOT TO SCALE

Figure 4-17

Stormwater Bioretention Soil Media Filters

SCALE: SITE
APPROACH: REMEDIATION

SCENARIO PLANNING: NOT SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

Bioretention is the process in which contaminants and sedimentation are removed from stormwater runoff through physical, biological and chemical treatment processes. Stormwater is collected into the treatment area which consists of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. Runoff passes first over or through a sand bed, which slows the runoff's velocity, distributes it evenly along the length of the ponding area, which consists of a surface organic layer and/or groundcover and the underlying planting soil. The ponding area is graded, its center depressed. Water is ponded and gradually infiltrates the bioretention area or is evapotranspired. The bioretention area is graded to divert excess runoff away from itself. Stored water in the bioretention area planting soil exfiltrates over a period of days into the underlying soils.

Technology Performance

Nitrogen Removal 25% to 45%

Phosphorus Removal 20% to 30%

$2,241
Removal Cost per kg N
(avg life cycle)

$20,912
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 10 years
Time to See Results

Stormwater Bioretention Soil Media Filters

SCALE: SITE
APPROACH: REMEDIATION

SCENARIO PLANNING: NOT SELECTED FOR USE
IDENTIFIED FOR PILOTING

SITING NEEDS

- GW depth > 4 feet
- Footprint is greatly scalable

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Management of Flooding / Extreme Events

PERFORMANCE CHALLENGES

- Open space required for construction

CLIMATE RESILIENCE: RISKS

- Reduced effectiveness of biological processes as a result of more frequent inundation or exposure to saline water (surface or ground water)

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor condition and performance of technology (i.e. achieving nutrient removal targets, health of vegetation)
- Species selection to ensure adequate performance in increasingly saline environments

Stormwater Constructed Wetlands, BMPs

SCALE: CAPE WIDE
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
PHYTOBUFFERS IDENTIFIED FOR PILOTING

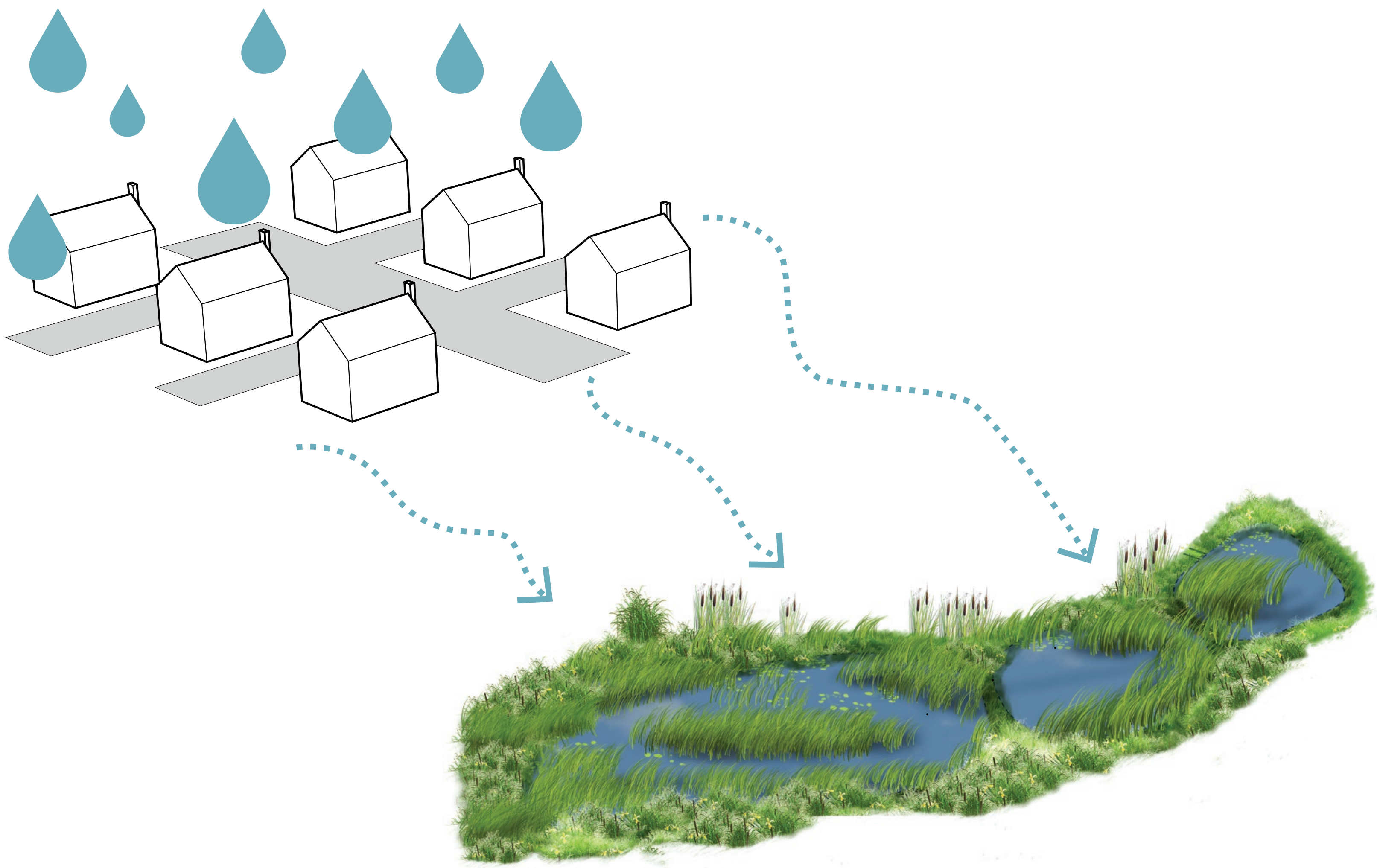


Figure 4-18

Stormwater Constructed Wetlands, BMPs

SCALE: CAPE WIDE
APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE
PHYTOBUFFERS IDENTIFIED FOR PILOTING

DESCRIPTION

There are several types of structural stormwater BMPs, such as phytobuffers, vegetated swales, and constructed wetlands, which can contribute to nutrient removal. These approaches typically employ an excavated elongated basin engineered to accommodate the requirements of the site, together with components designed to enhance nutrient attenuation. These components may include: a swale to convey runoff; a system of chambers that allow for filtration, sediment settling, aerobic and anaerobic activity; and vegetation for nutrient uptake. Vegetated swales are typically grassed parabolic basins with relatively flat side slopes. Phytobuffers employ fast growing poplars and willow trees to remove nutrients and other contaminants. Constructed wetlands filter stormwater as it flows horizontally through a sediment forebay and a series of gravel-bottomed wetland cells, where algae and microbes grow in abundance. Constructed wetlands can be engineered to mimic natural systems, but designed to improve residence time within anaerobic chambers, allowing for year round nitrogen removal.

SITING NEEDS

- Varies

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Management of Flooding / Extreme Events

PERFORMANCE CHALLENGES

- Requires the creation and enforcement of stormwater regulations and policies

CLIMATE RESILIENCE: RISKS

- Reduced effectiveness of biological processes as a result of more frequent inundation or exposure to saline water (surface or ground water)

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor condition and performance of technology (e.g. achieving nutrient removal targets, health of vegetation)
- Project design and species selection to ensure adequate performance in increasingly saline environments

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection

Technology Performance

Nitrogen Removal % 25 to 90

Phosporous Removal % 1 to 80

$156 to $1,900
Removal Cost per kg N
(avg life cycle)

$6,483 to $74,143
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 10 years
Time to See Results

4

RESTORATION

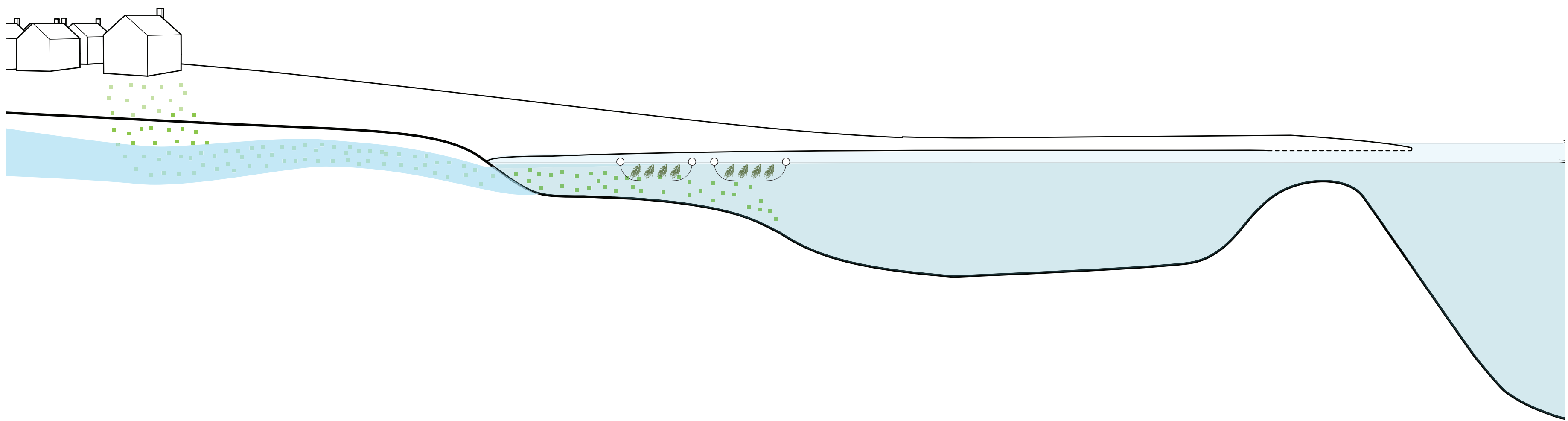


Figure 4-19

Aquaculture Mariculture

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: NOT SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

Seaweed and other marine vegetation remove nitrogen from their environment. The cultivation and removal of the marine vegetation can remove nitrogen from an estuary, reducing the estuary's nitrogen load. Mariculture can become a dual purpose project where seaweed can be harvested for market while there will be a local reduction in nitrogen in the overlying water column during the growth and maturation of the seaweed. This method of aquaculture cultivates marine vegetation such as seaweed to remove nitrogen. Harvesting a portion of the vegetation may be required to remove nitrogen. Mariculture can be used in combination with other types of aquaculture as well as floating constructed wetlands designed for brackish water.

Technology Performance

Nitrogen Removal 8% to 15%

Phosphorus Removal n/a

$61

Removal Cost per kg N
(avg life cycle)

20 years
Useful Life

1 to 3 years
Time to See Results

Aquaculture Mariculture

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: NOT SELECTED FOR USE
IDENTIFIED FOR PILOTING

SITING NEEDS

- Suitable area within estuary to cultivate mariculture

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Energy Savings / Nutrient Recovery / Recycling
- Improves Management of Flooding / Extreme Events

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection
- Army Corps of Engineers
- Office of Coastal Zone Management
- Board of Selectmen or Aldermen or designee
- Massachusetss Division of Marine Fisheries

PERFORMANCE CHALLENGES

- Growing conditions, aesthetics or navigation may limit applicability
- Seasonal nitrogen uptake coincident with natural cycle and algal blooms
- Requires removal of vegetation in order to take credit for nitrogen removal
- Nitrogen uptake subject to possible disruption due to disease or other
- Growth and harvest monitoring is important to maintain persistence of the benefit

CLIMATE RESILIENCE: RISKS

- Damage to shorelines or subsurface structures from storm events (e.g. wave action)

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor asset condition and performance of technology (i.e. achieving nutrient removal targets)
- Potential anchoring of structures
- Protective structures to reduce impacts to reefs (e.g. wind walls)

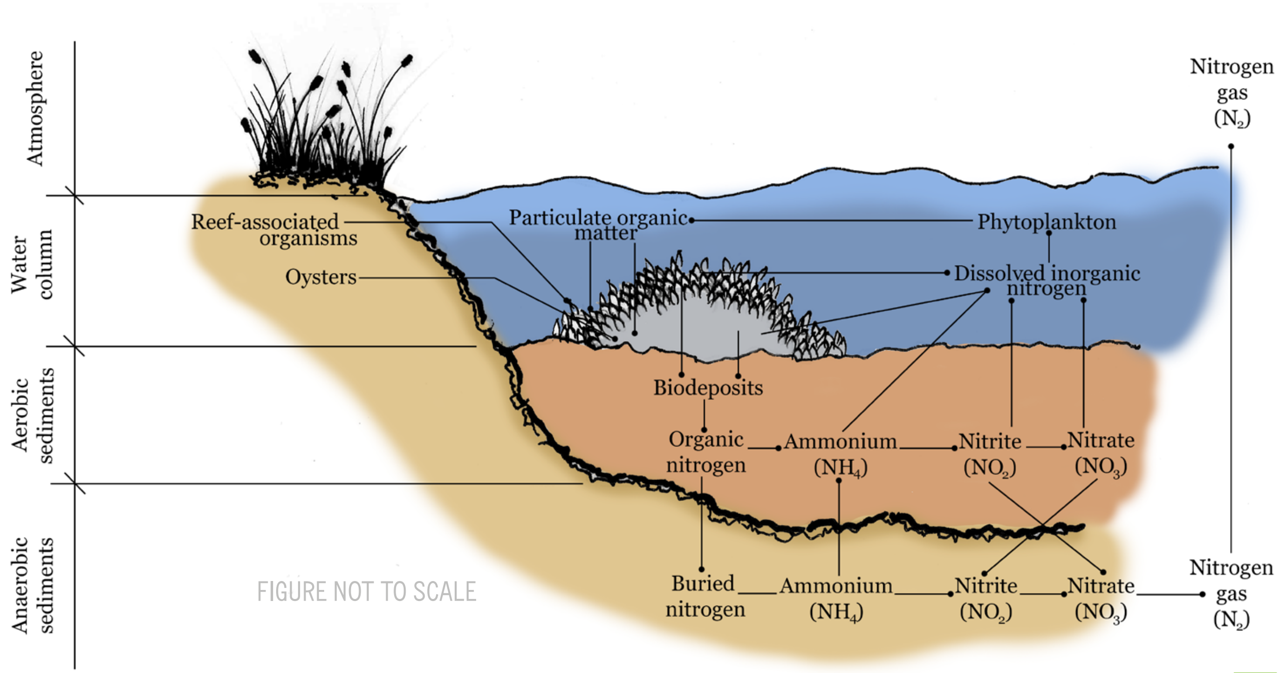


Figure 4-20

Aquaculture Shellfish

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

Shellfish, specifically oysters, remove nitrogen from their environment. The growing and removal of the mature oysters can remove nitrogen from an estuary, reducing the estuary's nitrogen load. Aquaculture can become a dual purpose project where shellfish are harvested for market while there will be a local reduction in nitrogen in the overlying water column during the growth and maturation of the oysters.

Shellfish may be cultivated above or within the estuary bed. The "in-estuary bed" method cultivates the shellfish in the benthic soils of the estuary. Shellfish may also be cultivated above the estuary bed in containters. With either approach, harvesting a portion of the oysters is required to remove nitrogen. Shellfish cultivation may be used in combination with other types of aquaculture (e.g mariculture), as well as floating constructed wetlands designed for brackish water.

Technology Performance

Nitrogen Removal 8% to 15%

Phosphorus Removal n/a

$61
Removal Cost per kg N
(avg life cycle)

20 years
Useful Life

1 to 3 years
Time to See Results

Aquaculture Shellfish

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

SITING NEEDS

- Suitable area within estuary to seed and cultivate shellfish

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Energy Savings / Nutrient Recovery / Recycling
- Improves Management of Flooding / Extreme Events

PERFORMANCE CHALLENGES

- growing conditions, aesthetics or navigation may limit applicability
- Seasonal nitrogen uptake coincident with natural cycle and algal blooms
- Requires removal of shellfish in order to take credit for nitrogen removal
- Nitrogen uptake subject to possible disruption due to disease or population crash
- Population monitoring is important to maintain persistence of the benefit
- Large concentrations of shellfish can generate waste products, reduce dissolved oxygen levels, and possibly generate ammonia
- Shellfish will undergo rapid growth to a marketable size after which they must be harvested.
- Can require large areas to gain significant nitrogen removal
- If the waterbody is closed for shell fishing, management will be required to prevent the shellfish from getting into the food supply

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection
- Army Corps of Engineers
- Office of Coastal Zone Management
- Board of Selectmen or Aldermen or designee
- Massachusetss Division of Marine Fisheries

CLIMATE RESILIENCE: RISKS

- Damage to shorelines or subsurface structures from storm events (e.g. wave action)

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor asset condition and performance of technology (i.e. achieving nutrient removal targets)
- Potential anchoring of structures
- Protective structures to reduce impacts to reefs (e.g. wind walls)

4

RESTORATION

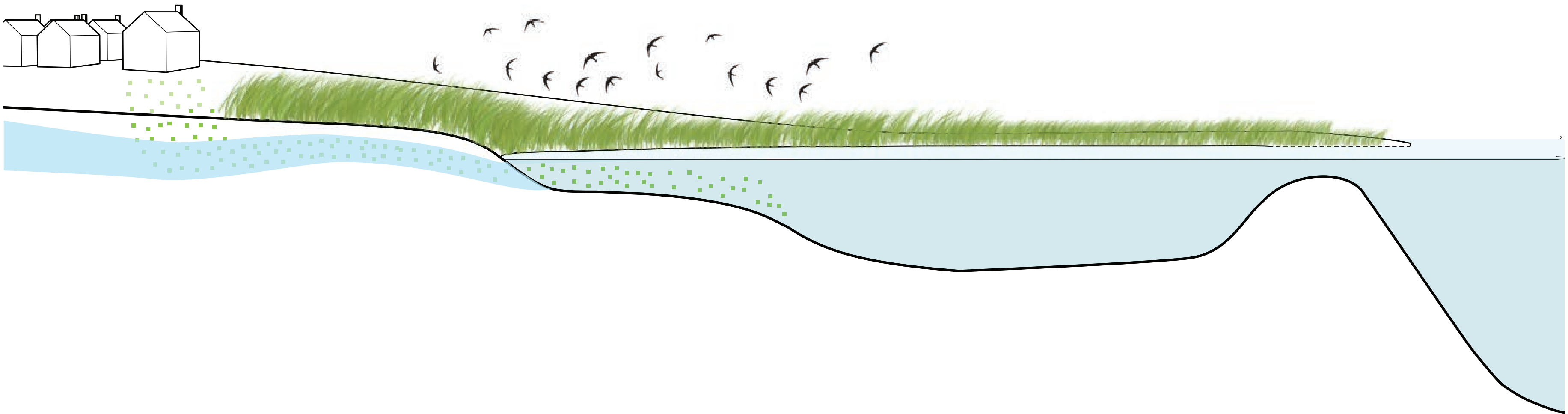


Figure 4-21

Coastal Habitat Restoration

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

Restoration of coastal habitats includes establishing and/or enhancing estuary salt marshes, eel grass beds, as well as shellfish and oyster beds together as an ecosystem.When considering restoration of coastal habitats, implementing these ecosystems jointly should be considered. The installation of riparian buffer zones and Floating Constructed Wetlands should be considered when restoring coastal habitats. Habitat restoration should focus on creating or rehabilitating habitats, including creating communities that are natural to the area.

Technology Performance

Nitrogen Removal 5% to 12%

Phosphorus Removal n/a

$163
Removal Cost per kg N
(avg life cycle)

20 years
Useful Life

0.5 to 3 years
Time to See Results

Coastal Habitat Restoration

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

SITING NEEDS

- Site specific requirements based on the characteristics of the estuary
- Suitable substrate in saltwater/ estuarine environments
- Suitable area within estuary to seed and grow shellfish

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Energy Savings / Nutrient Recovery / Recycling
- Improves Management of Flooding / Extreme Events

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection
- U.S. Army Corps of Engineers
- Office of Coastal Zone Management

CLIMATE RESILIENCE: RISKS

- Reduced effectiveness of biological processes as a result of more frequent inundation or exposure to saline water (surface or ground water)

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor condition and performance of technology (i.e. achieving nutrient removal targets and health of vegetation)
- Species selection to ensure adequate performance in increasingly saline environments
- Preserve areas / buffers to allow migration of salt marsh to higher elevations as MHW rises

4

RESTORATION

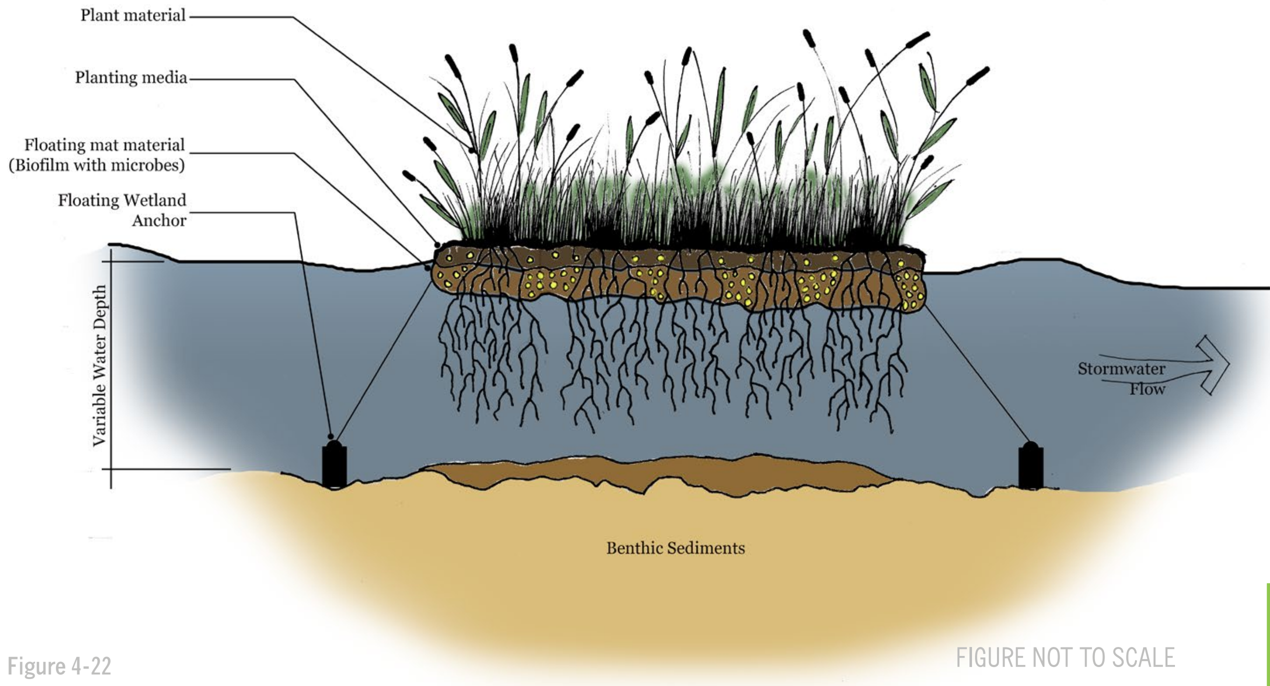


FIGURE NOT TO SCALE

Figure 4-22

Floating Constructed Wetlands

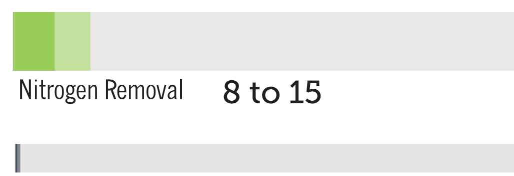
SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

DESCRIPTION

FCWs are manmade floating "islands" that act as floating wetlands that treat waters within ponds and estuaries. The islands are made of recycled materials that float on ponds or estuaries, exposing the plant's roots to the pond and estuarine waters. The root zones provide habitat for fish and microorganisms while reducing nitrogen and phosphorus levels. The floating islands can also be designed to allow shellfish and seaweed to grow which can be harvested, offsetting some of the systems costs. Some systems circulate surface water through the island, exposing the water to the root zones of the plants. The islands can be installed with shellfish beds and/or salt marsh grasses potentially assisting with their establishment. The islands are generally stationary and can be installed with walkways to access and maintain the plants growing on the islands. The islands require little O&M and do not need to be removed during the winter months, even if freezing water is a concern.

Technology Performance



Nitrogen Removal 8 to 15

Phosphorus Removal 0.5 to 1

$20
Removal Cost per kg N
(avg life cycle)

$454
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

0.5 to 3 years
Time to See Results

Floating Constructed Wetlands

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: SELECTED FOR USE
IDENTIFIED FOR PILOTING

SITING NEEDS

- Site specific requirements based on the characteristics of the estuary or pond
- A location(s) within the estuary or pond to locate a floating island year around

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Energy Savings / Nutrient Recovery / Recycling
- Improves Management of Flooding / Extreme Events

PERFORMANCE CHALLENGES

- Not listed

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection
- U.S. Army Corps of Engineers

CLIMATE RESILIENCE: RISKS

- Damage to structures from storm events (e.g. wind and wave action)

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor asset condition and performance of technology (i.e. achieving nutrient removal targets)
- Potential anchoring of structures
- Protective structures to reduce impacts to wetlands (e.g. wind walls)

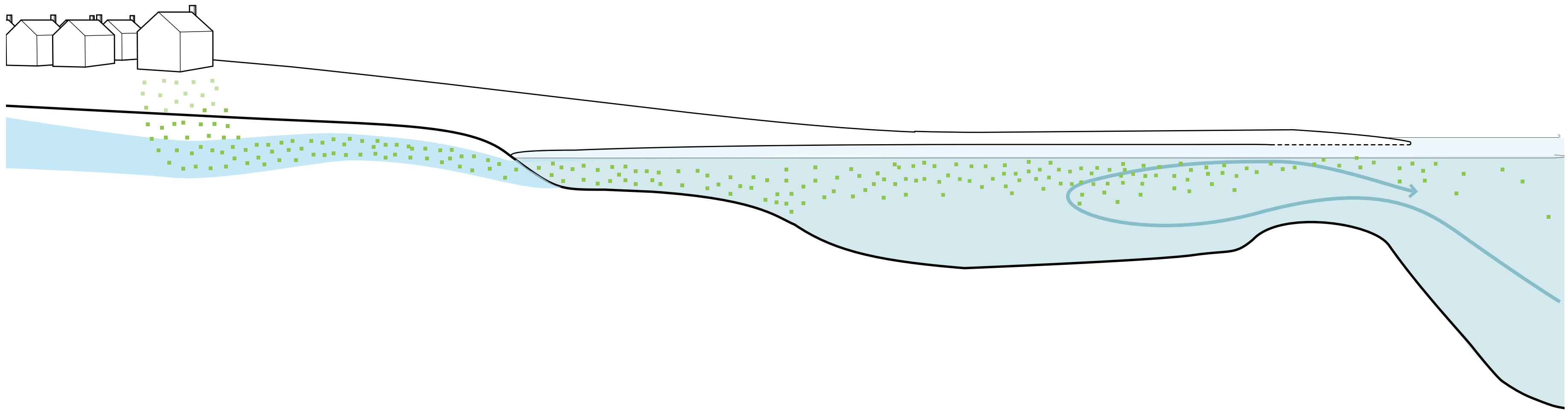


Figure 4-23

Inlet/Culvert Widening

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: SELECTED FOR USE

DESCRIPTION

This approach considers re-engineering and reconstruction of bridge or culvert openings to increase the tidal flux through the culvert or inlet. In the right settings, increasing the tidal flux can decrease the nitrogen residence time, lowering the nutrient concentration in the estuary and/or tidal marsh upstream of the widened inlet or culvert.

Technology Performance

Nitrogen Removal 8% to 15%

Phosphorus Removal 0.5% to 1%

$20
Removal Cost per kg N
(avg life cycle)

$464
Removal Cost per kg P
(avg life cycle)

10 years
Useful Life

0.5 to 3 years
Time to See Results

Inlet/Culvert Widening

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: SELECTED FOR USE

SITING NEEDS

- Site specific requirements, based on existing culvert bridge dimensions, hydraulics and other characteristics

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Energy Savings / Nutrient Recovery / Recycling
- Improves Management of Flooding / Extreme Events

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection
- U.S. Army Corps of Engineers
- Office of Coastal Zone Management

PERFORMANCE CHALLENGES

- Widening a tidal culvert or bridge could increase the depth of flooding during high tides and storm surges in flood prone area and upstream of the structure.
- Disruption of coastal processes must be considered
- Can have significant construction impacts
- Permitting requirements may be extensive and time consuming
- Modeling is required to accurately predict the upstream tidal and coastal process impacts of the culvert/bridge modifications
- Will only return an estuary to a more natural hydrologic regime if the original opening has been restricted

CLIMATE RESILIENCE: RISKS

- Damage to shorelines or subsurface structures from storm events (e.g. wave action)

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor asset condition and performance of technology (i.e. achieving nutrient removal targets)
- Potential anchoring of structures
- Protective structures to reduce impacts to reefs (e.g. wind walls)

Pond and Estuary Circulators

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: NOT SELECTED FOR USE

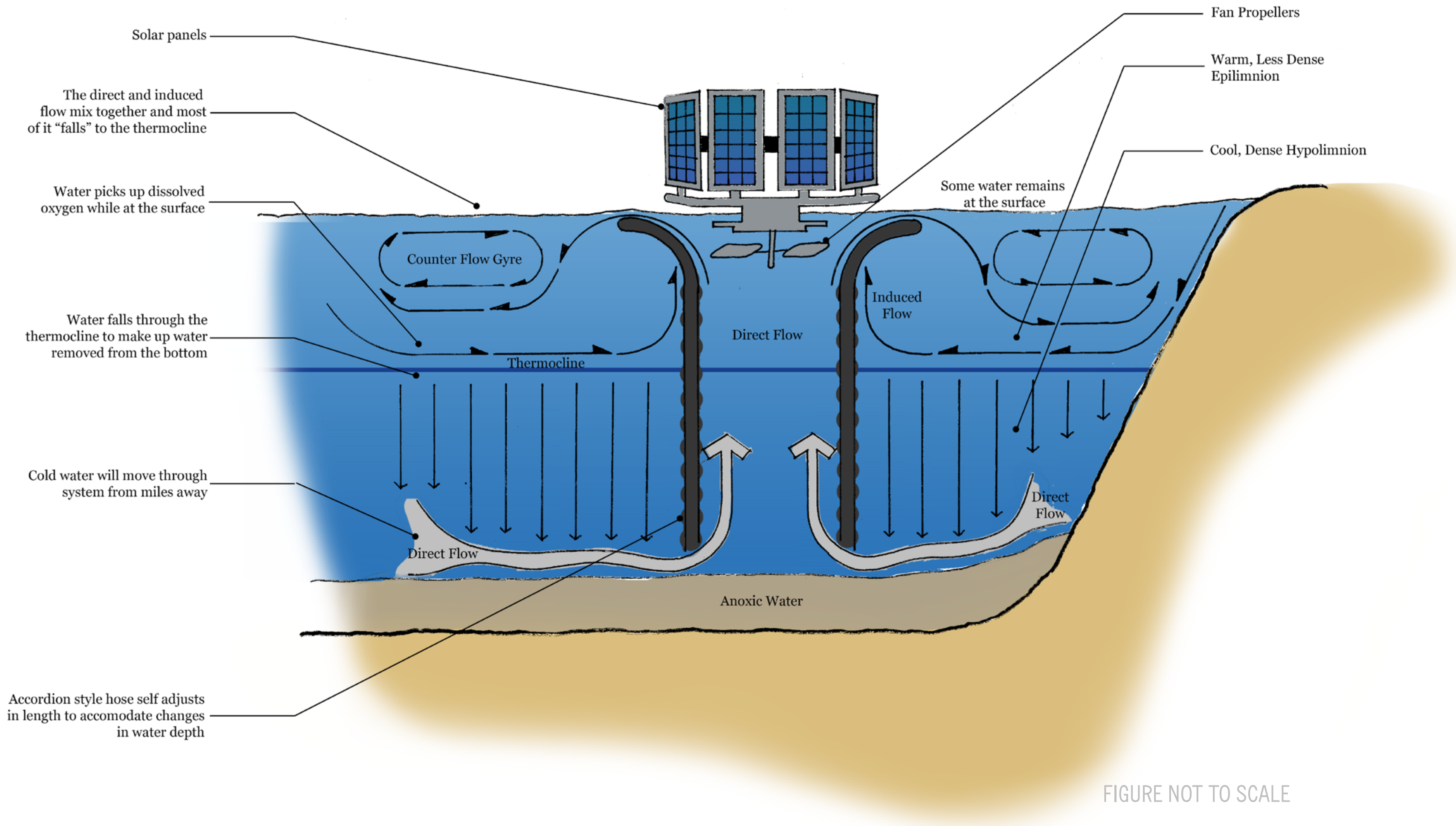


Figure 4-24

Pond and Estuary Circulators

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: NOT SELECTED FOR USE

DESCRIPTION

The circulation of pond and estuary water increases the oxygen concentration while reducing nutrients (nitrogen and/or phosphorus) concentrations, reducing odors, and enhancing fish habitat. The circulation is generally performed mechanically by installing solar or electric powered circulators.

Pond and estuary circulators work by reducing stratification in ponds and estuaries. Anoxic conditions can occur within the lower stratified layers leading to harmful algae blooms, fish kills and odors. Circulators mix these stratified layers, thereby increasing dissolved oxygen concentrations throughout the pond depths.

Technology Performance

10	0.5 to 3 years
Useful Life	Time to See Results

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection
- U.S. Army Corps of Engineers
- U.S. EPA

SITING NEEDS

- Site specific requirements based on the characteristics of the estuary or pond
- A location(s) within the estuary or pond to permanently locate floating island

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Energy Savings / Nutrient Recovery / Recycling
- Improves Management of Flooding / Extreme Events

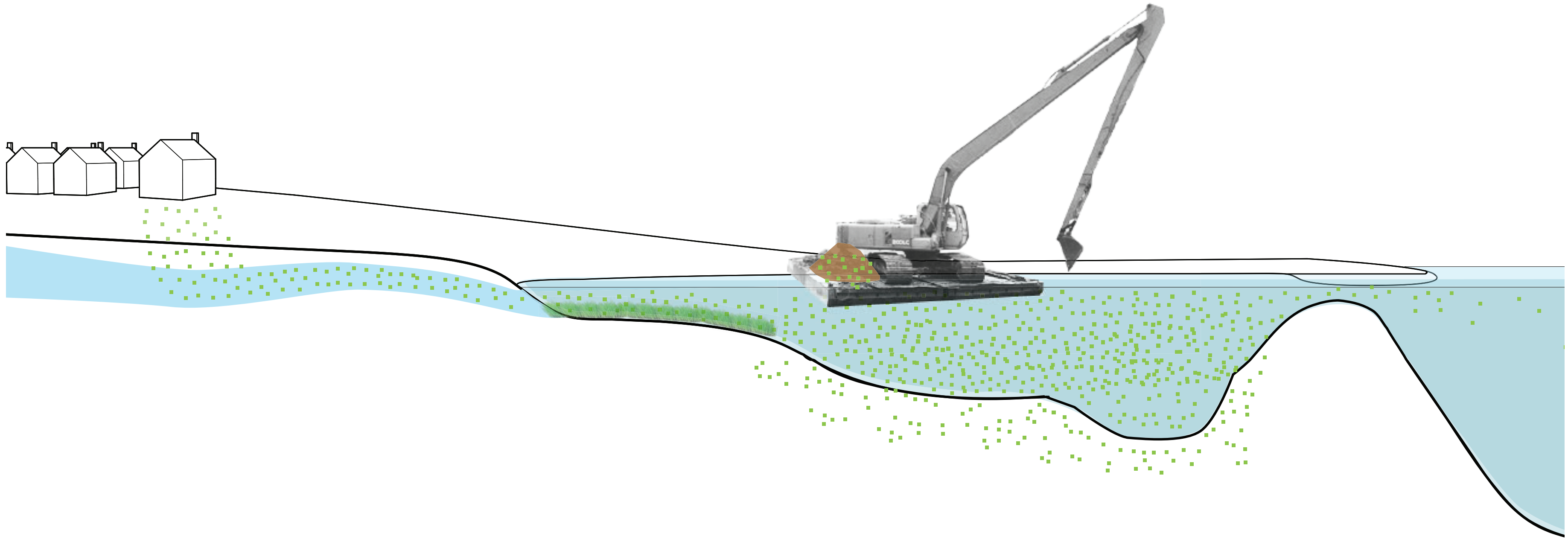


Figure 4-25

Pond and Estuary Dredging

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: SELECTED FOR USE

DESCRIPTION

Lakes, ponds, streams and estuaries store nutrients within their sediments. These sediments tend to accumulate over time. Subsequently, these nutrients can be released into the overlying water column and can become a major source of nitrogen and phosphorus. Dredging and removing these sediments and accumulated nutrients removes the nutrients from the water body and potentially the watershed.

Technology Performance

Nitrogen Removal 80% to 95%
from sediments removed

Phosphorus Removal 80% to 95%
from sediments removed

$7
Removal Cost per kg N
(avg life cycle)

$7
Removal Cost per kg P
(avg life cycle)

25 years
Useful Life

0.5 to 1 years
Time to See Results

Pond and Estuary Dredging

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: SELECTED FOR USE

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Management of Flooding / Extreme Events

PERFORMANCE CHALLENGES

- Permitting requirements may be extensive and time consuming
- Testing of sediment required
- Dredging can be highly disruptive to biological communities
- Depending on what other contaminants may be present in the sediments, disposal of the sediments may be costly

SITING NEEDS

- Site specific requirements, based on hydraulics and other characteristics

CLIMATE RESILIENCE: RISKS

- Damage to shorelines or subsurface structures from storm events (e.g. wave action)

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor asset condition and performance of technology (i.e. achieving nutrient removal targets)
- Potential anchoring of structures
- Protective structures to reduce impacts to reefs (e.g. wind walls)

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection
- U.S. Army Corps of Engineers
- Office of Coastal Zone Management

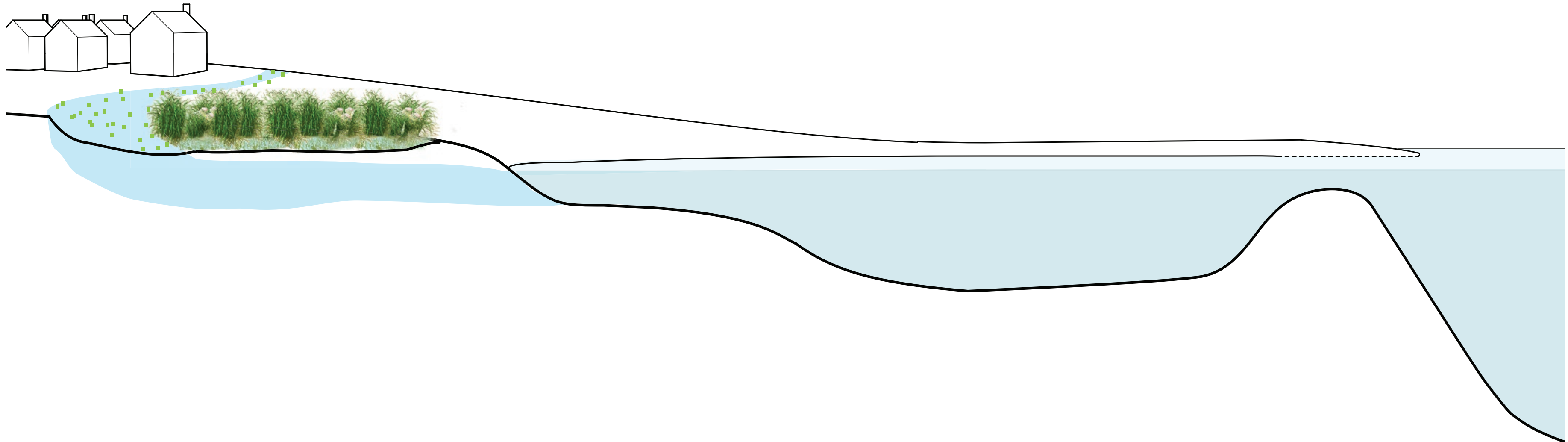


Figure 4-26

Surface Water Remediation Wetlands

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: SELECTED FOR USE

DESCRIPTION

Surface Water Remediation Wetlands are constructed to aid in water quality improvements to surface water bodies, usually streams or rivers. Water is directed or allowed to flow naturally through treatment cells containing wetlands. Surface water remediation wetlands are often used in combination with groundwater recharge or potable water reuse systems. Surface water remediation wetlands are generally used with free water surface wetlands due to their larger size, and lower capital and O&M Costs.

Technology Performance

Nitrogen Removal 70% to 95%

Phosphorus Removal 40% to 95%

$1,019
Removal Cost per kg N
(avg life cycle)

$1,246
Removal Cost per kg P
(avg life cycle)

20 years
Useful Life

1 to 5 years
Time to See Results

Surface Water Remediation Wetlands

SCALE: NEIGHBORHOOD/WATERSHED
APPROACH: RESTORATION

SCENARIO PLANNING: SELECTED FOR USE

SWR

SITING NEEDS

- Site specific requirements, based on hydraulics and other characteristics

ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Management of Flooding / Extreme Events

PERFORMANCE CHALLENGES

- Large land area required per amount of nitrogen removed
- Requires existing open space for construction

CLIMATE RESILIENCE: RISKS

- Damage to shorelines or subsurface structures from storm events (e.g. wave action)

CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor asset condition and performance of technology (i.e. achieving nutrient removal targets)
- Potential anchoring of structures
- Protective structures to reduce impacts to reefs (e.g. wind walls)

Permitting

POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection
- U.S. Army Corps of Engineers
- Office of Coastal Zone Management

Traditional Approaches for Nutrient Management

There are four categories of traditional infrastructure wastewater systems. These include:

- Individual on-site systems with and without enhanced nitrogen removal
- Cluster systems serving up to approximately 30 homes with aggregate wastewater flows less than 10,000 gallons per day (gpd)
- Satellite systems serving from 30 to 1,000 homes (wastewater flows between 10,000 and 300,000 gpd), intended to treat and dispose of wastewater from one area of a community
- Centralized systems that can provide for most or all of a community's wastewater management needs

These traditional approaches are summarized below; more complete discussions of individual treatment techniques can be found in Appendix 4A; the most detailed and extensive information can be found in the Technologies Matrix, available in Appendix 4B and on the web at: http://capecodcommission.org/matrix.

INDIVIDUAL ON-SITE SYSTEMS

The most common infrastructure on Cape Cod is individual on-site systems. These systems include cesspools, non-Title 5 compliant septic systems, Title 5 compliant septic systems, innovative/alternative (I/A) septic systems and enhanced I/A systems. All of these systems work similarly (**Figure 4-27**). Title 5 systems include a septic tank into which wastewater from households and businesses is discharged, and a distribution box from which effluent from the septic tank flows and is distributed to the soil absorption system (SAS), which releases the effluent to the ground. Cesspools do not include a distribution box, leach field, or SAS. The amount of nitrogen removed through denitrifying septic systems is about 40% and can be somewhat enhanced dependent on the soil type and the distance between the discharge and groundwater. Very sandy soils with little organic material, soils common on the Cape, provide less treatment than other soil types.

When estimating nitrogen concentrations being discharged to groundwater, Title 5 compliant systems have a discharge concentration of 26.25 milligrams per liter (mg/L). This concentration includes all denitrification that occurs in the wastewater within the septic system and in the unsaturated soils as it reaches the water table. The Massachusetts Department of Environmental Protection (MassDEP) approves I/A septic systems for 19 mg/L. This value is typically used when estimating nitrogen reduction for nutrient management plans. Enhanced I/A systems may achieve a greater reduction. I/A septic systems may play a significant role in helping to manage nutrients entering the groundwater.

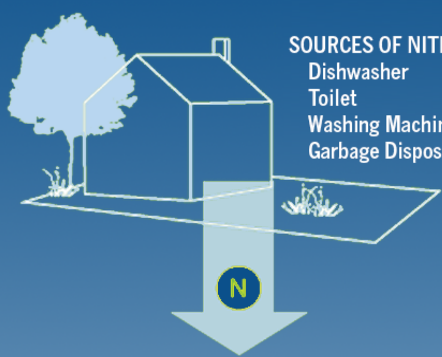
One of the limiting factors in optimizing the performance of I/A systems is variability and inconsistency in maintenance. Outside oversight of I/A systems, potentially at the municipal or county level, could improve performance. Management entities with oversight of private I/A systems can ensure high quality system installation and inspection, maintenance and operation, service provider training and certification, qualified installers and construction inspectors and performance tracking. There are many forms of so-called "Responsible Management Entities" (RME), including public utilities, regional service authorities and county entities, among others. Two US EPA documents – "Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems" dated March 2003, and "Handbook for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems" dated December 2005 – provide useful references for considering management oversight of on-site systems. The establishment of I/A management entities, and the definition of their essential roles and functions, is an area that merits further consideration. Currently, the Barnstable County Department of Health and the Environment (BCDHE) provides a maintenance and monitoring database to assist towns in meeting compliance requirements and the potential to expand this program could be considered.

On-Site Treatment systems

individual on-site systems

Individual on-site systems represent the most common traditional infrastructure on Cape Cod. These systems include cesspools, Title 5 compliant and non-Title 5 septic systems, and innovative/alternative (I/A) and enhanced I/A septic systems and any remaining cesspools.

Wastewater from households and businesses are collected and treated to varying degrees by microbes in these systems. Once treated, the liquid wastewater is discharged, leaving behind small amounts of solid waste.



The soil absorption system (SAS) from a Title 5 system is located at least four feet above the high water table under the discharge area.
A Title 5 system has the same general design as a non-Title 5 septic system, but meets MassDEP standards outlined in Title 5 regulations.

of the development on Cape Cod uses septic systems designed for wastewater treatment.

The amount of nitrogen reduction depends on soil type and distance to groundwater. Very sandy soils with little organic material, where are common on the Cape, allow septic system discharges to drain to the water table with less treatment than other soil types.

MassDEP has standards for maintenance, operation and approval of I/A and enhanced I/A septic systems that nitrogen to 19 and 13 mg/L of discharge.

On-Site Treatment Systems

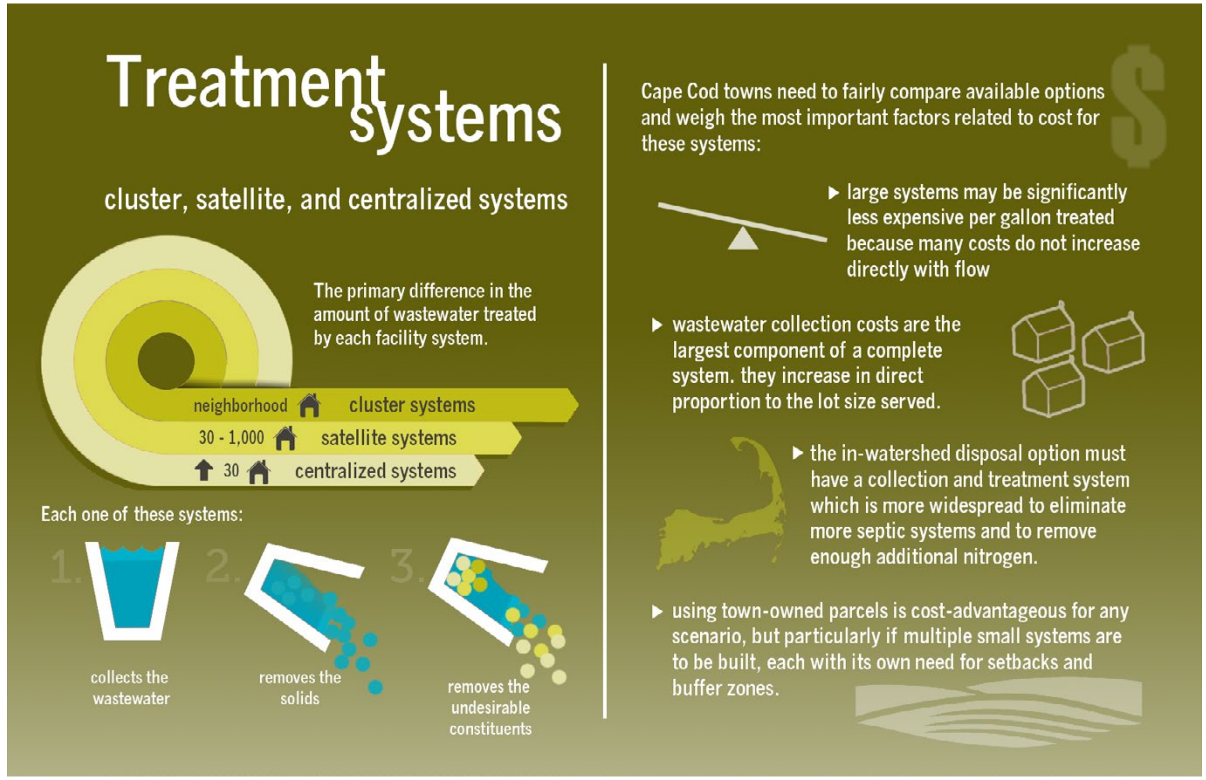
Figure 4-27

CLUSTER, SATELLITE AND CENTRALIZED SYSTEMS

Cluster, satellite and centralized systems all have a series of pipes and sometimes pumps that collect wastewater from multiple households and convey it to a centralized facility for the treatment and disposal of wastewater (effluent) and solids. The primary difference in the facilities is the amount of wastewater each treats. In general, cluster systems treat less than 10,000 gpd, satellite systems treat up to 300,000 gpd and centralized systems treat flows over 100,000 gpd (**Figure 4-28**).

Each of these systems collects wastewater, removes the solids, and through a series of treatment technologies treats the wastewater by partially reducing the undesirable constituents, including nitrogen and phosphorus, prior to discharge to the groundwater, surface water or an ocean outfall. The degree of removal is dependent on the treatment type and degree of treatment designed into the facility. In general, the greater the treatment, the greater the costs to design and build the facility and collection system, operate and maintain the facility, and treat and discharge the wastewater.

The effectiveness of traditional infrastructure can vary and is site-specific. Many wastewater pollutants can be managed with traditional systems, including nitrogen, phosphorus, total suspended solids, biological oxygen demand, pH, suspended metals, total petroleum hydrocarbon and pathogens. Traditional systems may be able to remove or manage some contaminants of emerging concern, though which CECs and how well they may be managed is still largely unknown. CECs are addressed in more detail later in this chapter.



Treatment Systems

Figure 4-28

Traditional infrastructure generally performs well when operated properly. However, it is possible for these systems to operate below their nutrient reduction potential if not operated properly. Decreases in performance can occur if the design flow is exceeded, the influent contains too much fats, oils or grease, or if the influent contains a compound that compromises the health of the microbes in the system.

ALTERNATIVES FOR EFFLUENT DISPOSAL

Once wastewater is collected and treated at a wastewater treatment facility (WWTF), the treated wastewater (effluent) is generally discharged to surface water or groundwater. There are tradeoffs in selecting sites or approaches for disposing of wastewater, including cost, efficiencies in reducing nutrients in the effluent and thereby meeting total maximum daily load (TMDL) targets and environmental considerations.

Even highly-treated effluent contains some nitrogen. If effluent is disposed of within a watershed with a TMDL as opposed to a location that is not impacted by nitrogen, more septic systems in that watershed must be eliminated or fitted with denitrification systems to meet the TMDL target. If land availability within a town dictates that effluent must be disposed of in public wellhead water supply recharge areas, then a higher level of treatment is needed at sharply increased costs for both capital facilities and operations and maintenance (O&M).

Federal and state laws regulate the dumping of waste into waters of the United States or the Commonwealth. The Massachusetts Ocean Sanctuaries Act of 1990, as amended, (Chapter 132A, §12A-16E, and §18) regulates discharge of wastes, including municipal wastewater, into the Commonwealth's ocean sanctuaries, rivers, and estuaries. As authorized by the federal Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Under this program, new WWTFs on Cape Cod may not discharge effluent to a freshwater body or stream.

The vast majority of WWTFs on Cape Cod are permitted with effluent recharged to the groundwater through beds, fields, or wells designed for specific locations and hydrogeologic site conditions. These conditions include soil characteristics, offset distance between the effluent discharge location and the groundwater layer and the environmental limitations imposed by natural and/or regulatory requirements. See Appendix 4A; Effluent Disposal for more information.

When thinking about siting new wastewater treatment alternatives, effluent disposal can occur at the site of treatment or remotely, depending on the availability of appropriate site conditions. The location of disposal sites may be inside or outside the watershed being served by the WWTF. Effluent transport out of the watershed is a possible option where conditions of the current watershed impose severe limitations or prohibit disposal of wastewater effluent. Looking beyond the borders of a nutrient-sensitive watershed may increase the number of potential disposal sites, may provide overall nutrient-removal efficiencies and may also realize cost efficiencies.

With these considerations in mind, finding disposal sites within direct discharge or outside of wellhead protection areas should rise to the top for Cape Cod communities. Identifying disposal sites will require careful analysis and in-depth community discussions. As a starting point, a GIS analysis may be used to identify sites that meet desirable criteria, including: sites that are outside of nutrient-sensitive watersheds, avoid sensitive resources and other receptors, and/or include under-utilized lands, such as MassDOT or Eversource Energy (formerly NSTAR) rights of way. A recommendation of this plan is the development of a detailed evaluation of effluent disposal options.

Recommendation S4.3: The Cape Cod Commission shall provide a detailed evaluation of effluent disposal options by September 2015.

ECONOMIES OF SCALE AND COST OF TRADITIONAL WASTEWATER TREATMENT

The Barnstable County Wastewater Cost Task Force was established to compile and analyze current local information on the costs to build and operate traditional wastewater systems on Cape Cod. Based on that information, the Task Force developed cost estimates for a wide range of wastewater system sizes and types to help Cape Cod towns fairly compare available options. The estimates are presented in the "Comparison of Costs for Wastewater Management Systems Applicable to Cape Cod," also known as the Barnstable County Cost Report (BCCR). This study was updated in 2014 to reflect additional available data and is included as Appendix 4C.

The application of the results allow communities to identify which options are best for their circumstances and thus streamline their watershed and wastewater planning.

Cost estimates are based on a uniform set of assumptions and supported by a review of actual data. They were prepared to be inclusive of all aspects of wastewater management: collection, transport, treatment, and disposal. Four measures of cost were considered:

- **CAPITAL COSTS**: The cost to design, permit and build the facilities, including land costs.
- **OPERATION AND MAINTENANCE (O&M) COSTS**: The ongoing expenses for labor, power, chemicals, monitoring, sludge disposal, etc.
- **EQUIVALENT ANNUAL COSTS (EAC)**: A mathematical combination of O&M expenses and amortized capital costs.
- **COSTS PER POUND OF NITROGEN REMOVED**: The equivalent annual cost divided by the annual nitrogen load removed from the watershed of a nitrogen-sensitive embayment.

Twelve scenarios were developed to combine capital and O&M costs for wastewater collection, transport, treatment and disposal and to compare those costs with the nitrogen removal that can be expected. Costs and performance were estimated both for base cases (with a uniform set of assumptions for all scenarios) and as part of a sensitivity analysis to determine how costs might change with assumptions that are either more or less favorable for each system size.

The sensitivity analysis allows for the identification of the most important cost factors, which are:

- **ECONOMIES OF SCALE**: Large systems may be significantly less expensive per gallon treated because many of the cost components do not increase directly with the flow.
- **DENSITY OF DEVELOPMENT**: Wastewater collection costs are the largest component of a complete system and they increase in direct proportion to the lot size served (**Figure 4-29** shows density, measured by road length between parcels).
- **LOCATION OF DISPOSAL FACILITIES**: An effluent disposal site within a nitrogen-sensitive watershed returns some of the collected nitrogen to the watershed because there is residual nitrogen in the effluent. Compared to a disposal site that is outside of a sensitive watershed, the in-watershed disposal option must have a collection and treatment system which is more widespread to eliminate more septic systems and to remove enough additional nitrogen to offset that returned in the effluent.
- **LAND COSTS**: Land suitable for wastewater management functions is scarce and expensive on Cape Cod. Using town-owned parcels is cost-advantageous for any scenario, but particularly if multiple small systems are to be built, each with its own need for set-backs and buffer zones. Land has been estimated at $250,000 per acre.

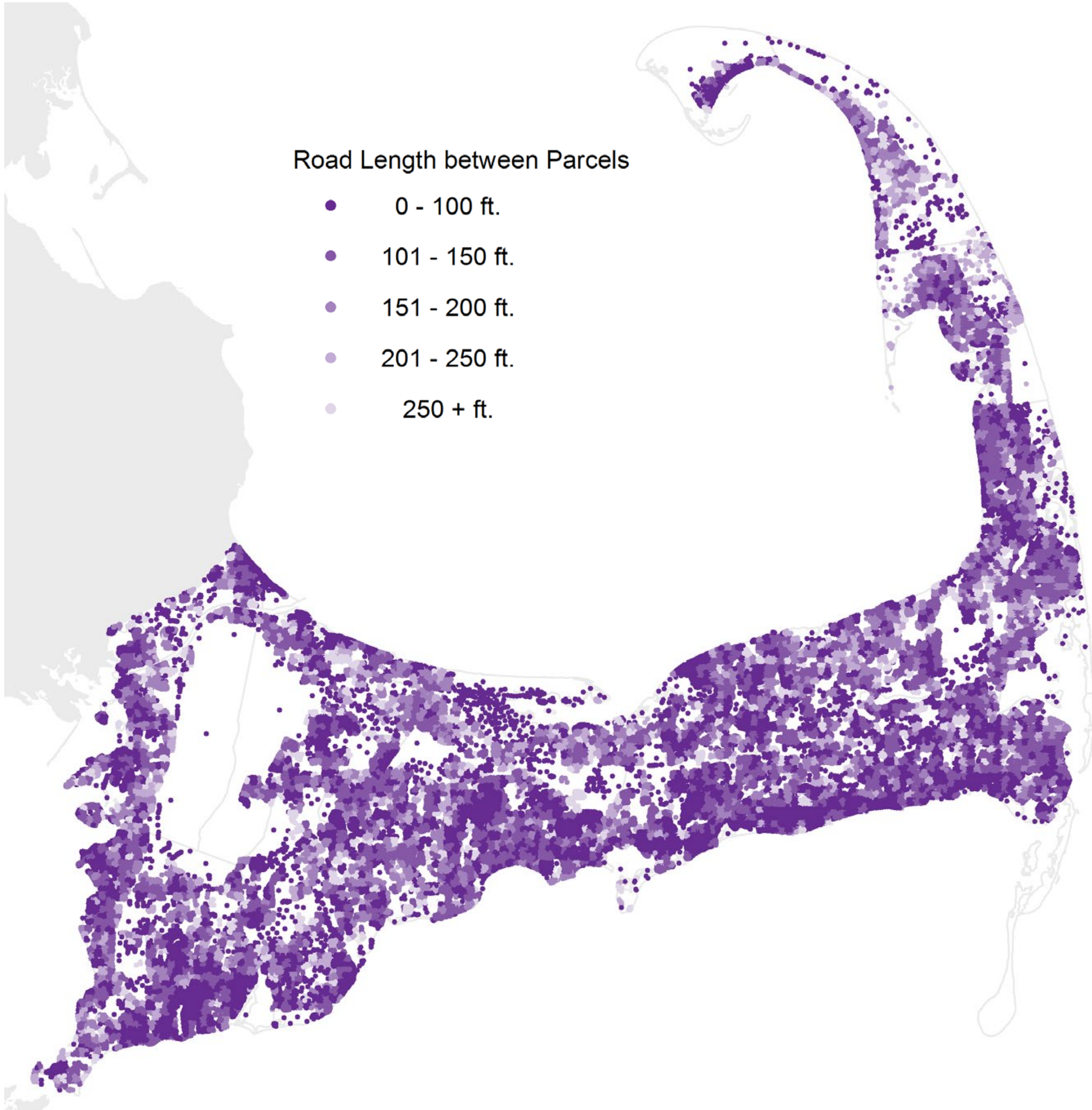
From this sensitivity analysis, conclusions can be drawn about the circumstances that favor one size of system over another.

- **INDIVIDUAL NITROGEN REMOVING SYSTEMS (I/A SYSTEMS)**: Their most efficient applicability is within areas of low density and in watersheds that require less than 50% wastewater nitrogen reduction. Their location on the parcel where the wastewater is generated eliminates collection costs.
- **CLUSTER SYSTEMS**: These systems should be considered for existing neighborhoods with small lots that are remote from sewered areas and have publically-owned land nearby. They also are good options for new cluster developments where infrastructure can be installed by the developer and later turned over to the town or for shorefront areas that may not be connected to larger-scale systems until later phases of a project.
- **SATELLITE SYSTEMS**: Satellite facilities make the most economic sense in remote watersheds (more than five miles from existing sewer systems or other areas of need), with vacant publically-owned land nearby. These systems are also applicable when existing or proposed private facilities can be converted to public operations and expanded to provide wastewater services to existing nearby properties on septic systems.
- **CENTRALIZED SYSTEMS**: This option is likely to be the most viable when:

- Dense development exists in nitrogen sensitive watersheds;
- Suitable treatment and disposal sites (outside sensitive watersheds and water supply recharge areas) are available at no or low cost;
- A high degree of nitrogen remediation is required;
- Areas of dense development in sensitive watersheds are within three miles of desirable effluent treatment and disposal sites; and
- Opportunities are available for cost reductions through regionalization.

Given the lack of required collection systems for the non-traditional technologies and approaches, traditional approaches are more likely to benefit from optimizing the factors described above. However, some non-traditional technologies, such as waste reduction toilets, may benefit from regional management arrangements for O&M. For example, a regional effort for managing urine and compost removal and/or reuse, as opposed to a town-by-town or even homeowner-by-homeowner arrangement, may present a cost savings.

Taking advantage of existing inter-municipal arrangements for water and/or wastewater is another potential cost savings method. For example, the Upper Cape Regional Water Supply Cooperative is a regional agreement to supply water to the four Upper Cape towns of Bourne, Falmouth, Mashpee and Sandwich. Management of the Cooperative is by a Board that represents the four public water supply systems – the Town of Falmouth, Bourne Water District, Mashpee Water District and Sandwich Water District. The wells for the Cooperative are located toward



Density as Measured by Road Distance Between Parcels

Figure 4-29

the north end of Joint Base Cape Cod (JBCC), in the town of Sandwich. JBCC is also the site of a federally-owned wastewater treatment facility with the potential to support regional wastewater management needs of the Upper Cape. Potential benefits could be realized in this area given the existing inter-municipal arrangement for water supply and the existing infrastructure at JBCC. More information on the JBCC infrastructure can be found in Chapter 7.

Growth Management Tools

Several planning tools are available for directing growth to appropriate locations where suitable infrastructure exists to support the resource use and wastewater management needs of development and/or where the impact to the environment is not as great. Land use tools such as compact and open space development, transfer of development rights, and nutrient reducing development may be utilized to manage growth and more efficiently utilize resources. These concepts are discussed in more detail in Chapter 7.

Merits of Traditional and Non-Traditional Nutrient Management Approaches

Using traditional technologies to manage wastewater on Cape Cod can offer many benefits, in the right setting. Traditional collection systems and treatment plants can reduce nutrient loads in wastewater before they hit groundwater. They can provide predictable and reliable levels of nutrient removal; they can provide infrastructure that may be retrofitted in the future to address contaminants of emerging concern (CECs), pharmaceuticals, and salt water intrusion. However, traditional technologies may not always offer the most cost-effective solution. Much of Cape Cod sprawls at a low density over miles of roadways, and the cost of installing collection systems may be prohibitively expensive. Additionally, traditional technologies can't remediate the concentration of nitrogen already in the groundwater and estuaries and embayments. Decades of disposal of nutrient-rich wastewater from Cape Cod septic systems resulted in concentrations of nitrogen and other contaminants that will take decades to migrate via the groundwater to ultimately discharge into the Cape's coastal waters. Approaches that remediate nutrient impacts in or adjacent to affected water bodies are important components of efficiently addressing water quality problems.

Many non-traditional techniques offer the promise of remediating water quality within the affected embayment or estuary, thereby having a more immediate result. Non-traditional technologies can intercept and remediate nutrient-laden groundwater close to the water body, or can remediate water in-situ, potentially resulting in faster water quality improvement. In addition, non-traditional approaches can have collateral benefits in the form of creating or improving habitat, one of the desired outcomes of implementation of the Section 208 Plan Update. Because many of the alternative approaches are ideally sited within impacted water bodies and employ natural systems to improve water quality, there is minimal or no water transport between watersheds. Remediation of water quality within coastal resource areas will likely provide additional ecosystem benefits as the "performance" of the coastal resources is enhanced. However, stakeholders have expressed concern about the reliability and/or performance of many of these non-traditional approaches. Many technologies are untested on Cape Cod. Research suggests that some alternative technologies could have widely ranging performance. Performance can be affected by seasonal temperatures, disease, storm damage or poor siting choices. Pilot projects will be needed to identify technologies that can be successfully, and reliably, employed on Cape Cod to remediate water quality.

Water Reuse

Over 97% of water on earth is salty and nearly 2% is locked up in snow and ice. That leaves less than 1% of water for human uses such as drinking, growing crops, household uses and commercial/industrial processes. This limited resource has driven the need for wastewater reuse.

The most common form of wastewater reuse is for non-potable purposes or water which is not used for direct human consumption. Treated wastewater is reused for beneficial purposes such as agricultural and landscape irrigation, industrial processes (such as cooling), toilet flushing and replenishing a groundwater basin (known as groundwater recharge). The quality of wastewater effluent to be reused is treated to standards, criteria and regulations considering the planned reuse.

“Gray water” is the term for the reuse of wastewater that originates from bathroom sinks, bath/shower drains and clothes washing equipment drains. Gray water can be reused onsite as a source of landscape irrigation. Recycled water can satisfy most water demands, as long as it is adequately treated to ensure water quality appropriate for the use. As for any water source that is not properly treated, health problems could arise from drinking or being exposed to recycled water if it contains disease-causing organisms or other contaminants.

Given the challenge of identifying new wastewater disposal sites, the reuse of treated effluent on Cape Cod should be considered in watershed solutions. MassDEP has promulgated regulations defining the reuse of treated wastewater depending on its final disposition. See Appendix 4A; Wastewater Reuse for more information.

Septage

Some significant percentage of wastewater generation will continue to rely on septic systems, at least into the foreseeable future. Consequently, there will continue to be demand for septage treatment. In the near future Barnstable County anticipates the release of the Septage and Food Waste Market Study prepared for the Town of Orleans by Stantec. Similar studies may be appropriate in other parts of the Cape to address the demand for septage processing, identify available facilities, and assess capacity. See Appendix 4A; Solids Collection, Treatment and Disposal Technologies for more information.

Recommendation I4.4:
Barnstable County or towns should commission septage studies to evaluate the demands for septage treatment.

Resiliency to Climate Threats: Sea Level Rise and the Potential for Increased Storm Severity

Massachusetts’ climate has changed and will continue to change over the course of the next century. Winter temperatures are increasing and extreme summer heat events are becoming more frequent (Massachusetts Climate Change Adaptation Report, Massachusetts Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee, 2011). The high emission scenario of the Intergovernmental Panel on Climate Change (IPCC), predicts that Massachusetts will experience a 5-10°F increase in average ambient temperature by the end of the century. The report cites further predictions that there will be 28 days each year that reach above 100°F, compared to only two days annually today.

Climate change will also affect water resources and coastal processes in Massachusetts. Under very conservative estimates, sea level will rise approximately 10 inches per century, which will increase the height of storm surge and associated coastal flooding frequency, inundate low-lying coastal areas, and amplify shore-line erosion. Even with successful mitigation strategies, these climate trends will continue for generations and new trends, such as increased intensity of hurricanes, are expected to emerge.

Cape Cod is vulnerable to these changes in climate. With 586 miles of tidal shoreline and only 10 miles of land at its widest point, the entire peninsula is vulnerable to the forces of storm activity, sea-level rise and catastrophic forces of hurricanes and nor’easters. The National Climate Assessment has documented an increase in heavy downpours, or extreme precipitation events, since 1958 in the Northeast region of the United States. Sea level rise will increase the region’s risk to coastal flooding especially when coupled with extreme precipitation events and increases in hurricane intensity. Also, as a result of sea level rise, water levels will rise and damage infrastructure and property along the Cape Cod coastline.

While the effects of climate change are projected to occur in the distant future, it will take years to develop and implement adaptation strategies for the region. The Section 208 Plan Update provides an opportunity to determine how to adapt the region’s water infrastructure to changes in climate, particularly as siting and construction of new infrastructure are considered.

The Association to Preserve Cape Cod, in partnership with the US Geological Survey (USGS) and the Cape Cod Commission, is conducting an assessment of the impacts of sea level rise on groundwater conditions in the Sagamore and Monomoy Lens. This study will assist the Commission

and towns in identifying vulnerable areas for proper infrastructure management. The results are anticipated in 2016.

An assessment of the threats to, and resiliency of, each nutrient management technology to the primary climate-related risks anticipated on Cape Cod was developed as part of this plan. For example, many of the techniques that rely on biological communities may benefit from increased air and ocean temperatures, improving performance through lengthened growing seasons. At the same time, anticipating increased intensity of downpours suggests that stormwater systems should be designed to accommodate higher runoff volumes.

In assessing the technology options, the following possible climate-related risks were identified:

- Damage to, or increased degradation of, structures and materials.
- Mobilization of contaminants into the environment as a result of storage system failures.
- Backflow of saline water into wastewater systems causing overflows, increased degradation of materials and change in biological processes.
- Reduced effectiveness of biological processes as a result of more frequent inundation or exposure to saline water.
- Destabilization of wastewater infrastructure as a result of change in groundwater levels or erosion.
- Restricted ability to access systems to collect outputs or re-use outputs due to salinity.

The following solutions were identified to help minimize the impact of the identified risks:

- Design systems to avoid hazard areas, or allow migration of vegetation as hazard areas change.
- Select materials, coatings and species that are able to cope with an increasingly saline environment.
- Install backflow valves on systems
- Anchor buried infrastructure
- Ensure frequent maintenance inspections to monitor infrastructure condition (e.g. rate of corrosion) and performance of technology (i.e. achieving nutrient removal targets).
- Use protective structures to reduce wave or wind impacts to systems.

See Appendix 4A; Sea Level Rise and Storm Surge Risks to Technology Options for more information and Appendix 4D for a summary of the risks and solutions that are relevant to each technology option that was assessed.

Ocean Acidification

Ocean acidification (OA) is one of the lesser-understood effects of increased carbon dioxide in the atmosphere. According to some research, one quarter of fossil fuel emissions fall on the ocean, causing it to acidify. There is evidence that acidification of the oceans may have significant impacts on ocean ecosystems. Shellfish growers in the Pacific Northwest have observed declining oyster harvests linked directly to ocean acidification. Scientists have documented poor shell development in certain classes of plankton under increased ocean acidity (WHRC Ocean Acidification and Southern New England Conference, October 2014). As ocean pH declines in ocean waters, direct impacts may be observed in some marine organisms, disrupting estuarine and marine ecosystems, affecting the fishing economy, and possibly having adverse effects on some of the technologies that have shown promise in mitigating the nutrient loading problems in coastal waters. More research is needed to understand the effects of ocean acidification on shellfish and other organisms on Cape Cod. In the meantime, OA should be recognized as one of the potential challenges in implementing restoration-based techniques over the long-term.

Contaminants of Emerging Concern

Contaminants of emerging concern (CECs), as described in Chapter 2, include chemicals found in the environment where the risk to human health and the environment is not well known. The US EPA identifies CECs, including pharmaceuticals, personal care products, polybrominated diphenyl ethers (PBDEs) and perfluorinated compounds (PFCs) as requiring further study. The US EPA has undertaken national testing for CECs in public water supplies, referred to as the Unregulated Contaminant Monitoring Rule (UCMR). Monitoring is required for

supplies serving over 10,000 connections or by voluntary action. A number of water suppliers have volunteered to have their supplies tested. As data becomes available through the UCMR the US EPA will be able to target more prevalent contaminants for review, research and action.

Several stakeholders have raised questions about how the technologies considered for water quality remediation might address CECs, and how the plan will address this growing concern. There is still a lot to understand before action can be taken: what priorities to set, what technologies can address the priority contaminants, and what other actions to take to prevent the introduction of CECs into the waste stream. The study and regulatory changes that may be needed are outside the scope of this plan update, but should be the continuing focus of federal and state research and regulatory bodies.

Identifying Suitable Locations for Non-Traditional Technologies: GIS Screening Analysis

The alternative technologies offer different opportunities and limitations for application in the development of watershed-based solutions. Many of the considerations for siting a technique are based on the physical characteristics of the land. During the section 208 planning process, identifying viable potential sites for specific nutrient management techniques became an important objective in understanding the opportunities for using alternative technologies on Cape Cod. With this goal in mind, criteria were selected that define the necessary characteristics for identifying an appropriate site for a particular alternative technology. These criteria were then applied through a Geographic Information Systems (GIS) parcel analysis to rank potential sites for their suitability to support a given technology, and illustrate these opportunities in a map. These GIS site screening analyses have been performed for several alternative technologies, including:

- Constructed wetlands
  - For wastewater treatment
  - For groundwater treatment
  - Saltwater wetland expansion, migration, or restoration
- Phyto-technology
- Permeable reactive barriers - injection well
- Permeable reactive barriers - trench
  - Trench type along roads
  - Trench type in areas other than along roads

The results of these analyses, as well as relevant resource information, will be made available as a resource through the Watershed Team technical assistance program, as described in Chapter 5. Additional GIS screening analyses are needed for additional technologies.

More detailed information on the criteria identified for each technology and how the screening was applied may be found in Appendix 4E.

Selection of Pilot Projects

Many of the practices identified for nutrient management need to be piloted locally in order to determine their effectiveness and identify with more certainty potential construction and operation and maintenance costs. Some of the techniques collected in the Technologies Matrix show more promise for positively contributing to nutrient management on Cape Cod than others. The most promising practices have been identified as such in the summary descriptions presented earlier in this chapter.

Many of these, however, require site-specific evaluation to determine their applicability on Cape Cod, and are recommended for piloting. To minimize risk and avoid having many communities expend funds and time to design and install technologies that may not perform as hoped, a small number of pilot projects should be implemented in settings that allow for fair evaluation of performance. Site selection and pilot project design should also ensure that the results may be transferred to other Cape Cod settings, to the extent feasible.

As part of the Section 208 Plan Update, the Cape Cod Commission suggests that criteria for identifying and evaluating potential technologies and specific sites eligible for pilot programs on Cape Cod be established.

Recommendation S4.5: The Cape Cod Commission, in conjunction with MassDEP, shall establish criteria for eligible pilot projects.

The criteria should include factors that will ensure that the pilot projects fairly evaluate performance, and also allow for transferability among Cape Cod communities .

Recommendation S4.6: In coordination with US EPA and MassDEP, the Cape Cod Commission shall work with communities, state and federal agencies to identify opportunities to implement pilot projects in suitable locations across Cape Cod.

Several locally supported pilot projects are in progress or anticipated by the towns and are discussed in more detail in Chapter 2. These include aquaculture in Wellfleet, Falmouth and Mashpee, eco-toilets in Falmouth and testing of I/A systems by the BCDHE at the septic system test center.

The United States Environmental Protection Agency (US EPA) received $2 million in funding in FY14 to begin implementing the Southeast New England Coastal Watershed Restoration Program (SNECWRP). SNECWRP is a partnership among public and private stakeholders collaborating to create a broad ecological and institutional framework for protecting and restoring the coastal and watershed area in Connecticut, Rhode Island and Massachusetts.

In FY14, the two National Estuary Programs (NEPs) – Narragansett Bay and Buzzards Bay – awarded $723,869 and $728,559, respectively, on behalf of SNECWRP for projects in their study areas. The Buzzards Bay NEP awards included a $50,000 award to the Buzzards Bay Coalition to fund restoration efforts in Red Brook Harbor in Bourne through the development of a public-private partnership that will supply wastewater treatment to an existing development and a $250,000 award to the Town of Falmouth to upgrade septic systems adjacent to West Falmouth Harbor. An additional $500,000 in technical assistance through a US EPA contract was awarded to the towns of Barnstable and Chatham to develop preliminary stormwater best management practices (BMPs). Project selection required an emphasis on demonstrating early environmental success and/or laying the groundwork for more expansive efforts in the near future. It is anticipated that similar future federal funding will be available to support pilot projects in the region.

Monitoring

Monitoring for water quality improvements and performance of technologies will be necessary elements of implementing the Section 208 Plan Update. Monitoring is important to measure progress toward meeting water quality goals; it will provide baselines and metrics for adjusting a watershed approach through an adaptive management plan. This section summarizes some of the necessary components of monitoring for water quality improvement on Cape Cod.

EXISTING MONITORING

All of the embayments studied by the Massachusetts Estuaries Project (MEP) have established stations that were monitored for a period of three years or more for development of the technical reports. Monitoring of embayment water quality is continuing on a year to year contract basis with some towns, but a number of programs have been reduced or discontinued. The Cape is fortunate that many ponds continued to be monitored through the Pond and Lake Stewardship (PALS) program and that specific pond assessments and restoration projects are proceeding. Drinking water supplies and wastewater treatment facilities continue to be monitored through state permitting programs. Some stormwater outfalls are monitored as part of NPDES compliance and more monitoring will likely be required under the proposed draft Municipal Separate Storm Sewer Systems (MS4) permit. In many cases, active monitoring programs rely heavily on citizen volunteers. The development of watershed scenarios will require baseline monitoring of affected water bodies to establish water quality metrics and goals. Ongoing monitoring specific to informing whether progress is made toward meeting watershed goals or an individual pilot project's performance will need to be customized to the setting.

NON-TRADITIONAL TECHNOLOGY MONITORING

The need to better understand the effectiveness of non-traditional technologies will require rigorous technology-specific performance monitoring. At a minimum, a

monitoring protocol should include an assessment of downgradient resources or sensitive receptors, placement of monitoring stations, parameters of evaluation, methods for collecting and analyzing data, and frequency of data collection. Reasonable time frames for piloting a project must be established, and should take into account:

- acceptable timeframes for achieving water quality goals,
- extent of water quality degradation,
- anticipated time for performance, and
- occurrence of anomalous events, such as hurricanes or other weather.

Monitoring protocols for non-traditional technologies are in development. These draft protocols will be made available in a technical guidance document by September 2015. Specific protocols will need to be developed as pilot projects move forward.

Monitoring to understand the impacts of stormwater infrastructure upgrades and the effectiveness of fertilizer reduction programs will also require site-specific monitoring and extrapolation of performance and compliance monitoring results to determine effectiveness.

Recommendation I4.7: Performance monitoring shall be required for all technologies.

MONITORING COMMITTEE

With the extensive monitoring required to implement the Section 208 Plan Update, an ad hoc Monitoring Committee was established in April 2014 to review monitoring needs and make recommendations. The Monitoring Committee has discussed non-traditional technologies and characterized general monitoring approaches for piloting. The Committee is developing eight conceptual protocols for aquaculture, shellfish bed restoration, inlet widening, permeable reactive barriers, innovative/alternative septic systems, eco-toilets and constructed and floating wetlands. The Committee has been working to identify criteria for selecting and prioritizing pilot projects of nutrient remediation technologies, as well as developing a strategy and framework for evaluating the performance of these technologies. It is anticipated that monitoring data collected from the pilot projects will support updates to the Technologies Matrix. The Committee is also charged with developing specific recommendations for improving baseline and compliance monitoring in the region and identifying needs and services that will be necessary to support implementation of the Section 208 Plan Update. Committee recommendations will be detailed in a technical guidance document and implemented through permit conditions at the state and regional levels.

Recommendation I4.8: Draft monitoring protocols for non-traditional technologies shall be provided by the Cape Cod Commission based on input from the Monitoring Committee in a Technical Guidance document by September 2015.

It is recommended that the ad hoc Monitoring Committee become a standing committee and continue to support implementation of the Section 208 Plan Update. In addition, the Committee should identify and track developing issues (such as contaminants of emerging concern, or climate change) that may affect performance of technologies, or progress toward improving water quality in coastal embayments.

Recommendation I4.9: The Cape Cod Commission shall create a standing Monitoring Committee to support implementation of the plan and identify and track developing issues, such as CECs and climate change impacts to technology performance, subject to available resources.

DATA WAREHOUSE

Data collection to demonstrate progress toward water quality goals presents both an opportunity and a challenge. As conceived in this plan, the extensive monitoring recommended will result in large quantities of data that will need to be stored, managed, and made accessible to the public. A data warehouse and "custodians" are needed: significant storage capacity will be needed, as well as the structure to support the data, and a web-based interface. Technical studies, reports, and maps that may be generated as a result of data analysis will need to be housed and made available to the public. To date, monitoring data has not been readily available on Cape Cod.

The Commission's Strategic Information Office (SIO) currently maintains an expansive data warehouse, and the Commission's Watershed Management Program maintains a regional historic warehouse of water resources information on behalf of Barnstable County and the 15 towns. Data hosting and maintenance would be available for a robust monitoring program providing consistent and accurate data feedback loops among the towns and appropriate agencies. This Plan Update recommends that the Cape Cod Commission assume responsibility for monitoring and maintaining regionally consistent data sets that are freely accessible to the public. Maintaining data in a centralized, accessible location will allow information to transfer from one project to another, and assist the region in prioritizing projects based on water quality improvements and/or further degradation.

Recommendation I4.10: A regional water quality monitoring program and data warehouse shall be established and the Cape Cod Commission shall assume responsibility for monitoring and maintaining regionally-consistent data sets that are freely accessible to the public, subject to available resources.

05 EVALUATION

The Cape Cod Model - Regional Watershed Analysis

A watershed approach looks at the jurisdiction of the problem – watersheds. Of the 53 watersheds to coastal embayments on Cape Cod, 32 are shared by more than one town. The current regulatory process often requires town wide planning which, in many areas, represents only a partial solution to the problem. This document outlines a technical review process designed to provide insight into new and innovative ways of implementing solutions at the watershed level. Conversations to date have resulted in polarizing local debates, sometimes discussed in terms of centralized versus de-centralized approaches or traditional solutions versus alternative solutions. One of the key distinctions depends on a considered option's reliance on a permanent physical connection among multiple sources, a collection system. The process outlined in this report grouped points of view associated with these categorizations into two approaches to solving Cape Cod's nitrogen problem: a traditional approach and a non-traditional approach.


TEAM 1
Collection Systems
Traditional Approaches
cost and effectiveness
septic nitrogen load
economies of scale
potential limitations
permittable
TEAM 2
Non-Collection Systems
Non-traditional Approaches
total controllable nitrogen load
watershed/embayment options
innovation
nitrogen reduction credits
no collection
Scenarios define the outer bounds of an adaptive management plan

Chapter 5: The Cape Cod Model - Regional Watershed Analysis

The regional analysis of watersheds began with a review of local nutrient management planning, consideration of the best available scientific assessments and the collection of all relevant geographic data. Most Cape Cod communities have been engaged with nitrogen planning but few have moved forward to construct watershed scale projects capable of protecting and restoring water quality.

It's not a lack of awareness on the issue. Many local decision-makers have an understanding of the nitrogen problem and the accompanying environmental and economic threats. Wastewater always ranks high in surveys inquiring about the biggest challenges for the region. Education is important, but it's not the reason communities have struggled to address the problem.

It's not an engineering problem either. There are many engineering solutions that will remove enough nitrogen to meet standards. Many towns have offered such plans only to have them rejected by voters.

Existing regulation drives a traditional wastewater planning process, producing a predictable and narrow set of point source solutions to a non-point source problem without point source enforcement action. This creates an equally predictable implementation problem. The local communities sense the mismatch and resist the proposals. The existing regulatory framework is part of the problem.

It's a design problem. Proposed solutions have to be designed with more emphasis on the cultural identity of the community involved. The process should examine an expanded number of options and develop a range of simulated outcomes communicated in a geographic context with greater public participation and community engagement. The Cape Cod Commission, in the technical review and regional watershed analysis, piloted this approach. Lessons learned inform a recommended process for local communities in developing achievable water quality solutions by promoting efficient and effective watershed planning, expanding technologies and policies available to communities, and using new decision support tools to empower citizens and stakeholders.

Image on facing page: The Section 208 Plan Update utilized two different technical teams to develop two different approaches in each watershed. The outcome is a hybrid process that considers both traditional and non-traditional technologies together in a watershed. Together, this process reflects the outer bounds of an adaptive management plan with a locally preferred combination of technologies for implementation.

A New Approach

Cape Cod's geology, density patterns and lack of existing infrastructure support a new approach to addressing water quality goals in the region. The Section 208 Plan Update suggests a new approach to gain consensus earlier in the process, to ensure that shared watersheds are addressed, and to better coordinate needed infrastructure expenditures with municipal budgets. Striving for stakeholder consensus early in the planning process, including consensus on the range and locations of technologies to be employed, will lead to more community support during implementation than Cape Cod communities have seen to date. Watershed scenarios should include more detailed discussions about the development of adaptive management plans to

identify phasing strategies for implementation, the risks and benefits associated with each technology, piloting and monitoring necessary to support the approach, and the ability of a community to pay for the solution.

The regional watershed analysis creates a framework for local decision-making. It does not attempt to produce a preferred solution, but instead provides decision-support tools to help define a range of possible options to meet water quality standards, leaving the selection of specific strategies to the local communities closest to the problem.

This approach integrates science, design and information. Evaluating environmental problems in a geographic context with active stakeholder participation and collaboration, the process interactively considers issues of representation, process, change, impact, evaluation and decision-making.

DECISION SUPPORT TOOLS

The Commission developed a number of decision support tools, using data described in Chapter 4, to facilitate the creation of watershed scenarios and adaptive management plans. These new decision support tools and the supporting databases and methodologies will be available through the Cape Cod Commission's Watershed Team technical assistance program discussed later in this chapter. Some are still in development and/or undergoing beta testing. These tools make complex data sets easier to understand and provide an avenue for increased informed deliberation at the local and hyper-local planning levels, expediting the selection and implementation of watershed solutions.

Tools related to scenario development include the following:

- **WATERSHEDMVP (MULTI-VARIANT PLANNER):** A dynamic web-based, geospatial scenario planning tool developed by the Cape Cod Commission that allows technical experts and the general public to compare various water quality management options at scales ranging from the neighborhood, watershed and subregional level (www.watershedmvp.org).
- **WATERSHED TRACKER:** A companion tool to WatershedMVP that tracks nitrogen loads and interventions chosen by the user.
- **SITE SCREENING VIEWER FOR NON-TRADITIONAL TECHNOLOGIES:** A geographic information systems (GIS)-based data analysis of non-traditional technologies and approaches to weigh potential nitrogen attenuation enhancements, improvements to existing green infrastructure networks and conditions necessary to maximize effectiveness.
- **WATERSHED CALCULATOR:** A tool used to track cumulative nitrogen reductions and cost through the layered application of technologies in a watersheds to meet reduction targets.
- **TECHNOLOGIES MATRIX:** A flexible, dynamic and continually updated source of performance and cost information on currently available technologies and approaches for reducing nitrogen from wastewater, groundwater and saltwater and their applicability for use on Cape Cod.
- **SCENARIO ASSESSMENT MODEL (SAM):** A web-based assessment and decision model that allows communities to identify priorities and evaluate scenarios in terms of social impacts, reliability of solutions, and cost considerations.
- **BARNSTABLE COUNTY COST REPORT UPDATE:** The 2014 update by AECOM to the 2010 report "Comparison of Costs for Wastewater Management Systems Applicable to Cape Cod" by the Barnstable County Wastewater Cost Task Force (2010 report prepared by the Barnstable County Wastewater Cost Task Force) on Cape-wide collection, treatment, disposal, and non-traditional approaches prepared to provide an updated basis for financial decisions in the Section 208 Plan Update.

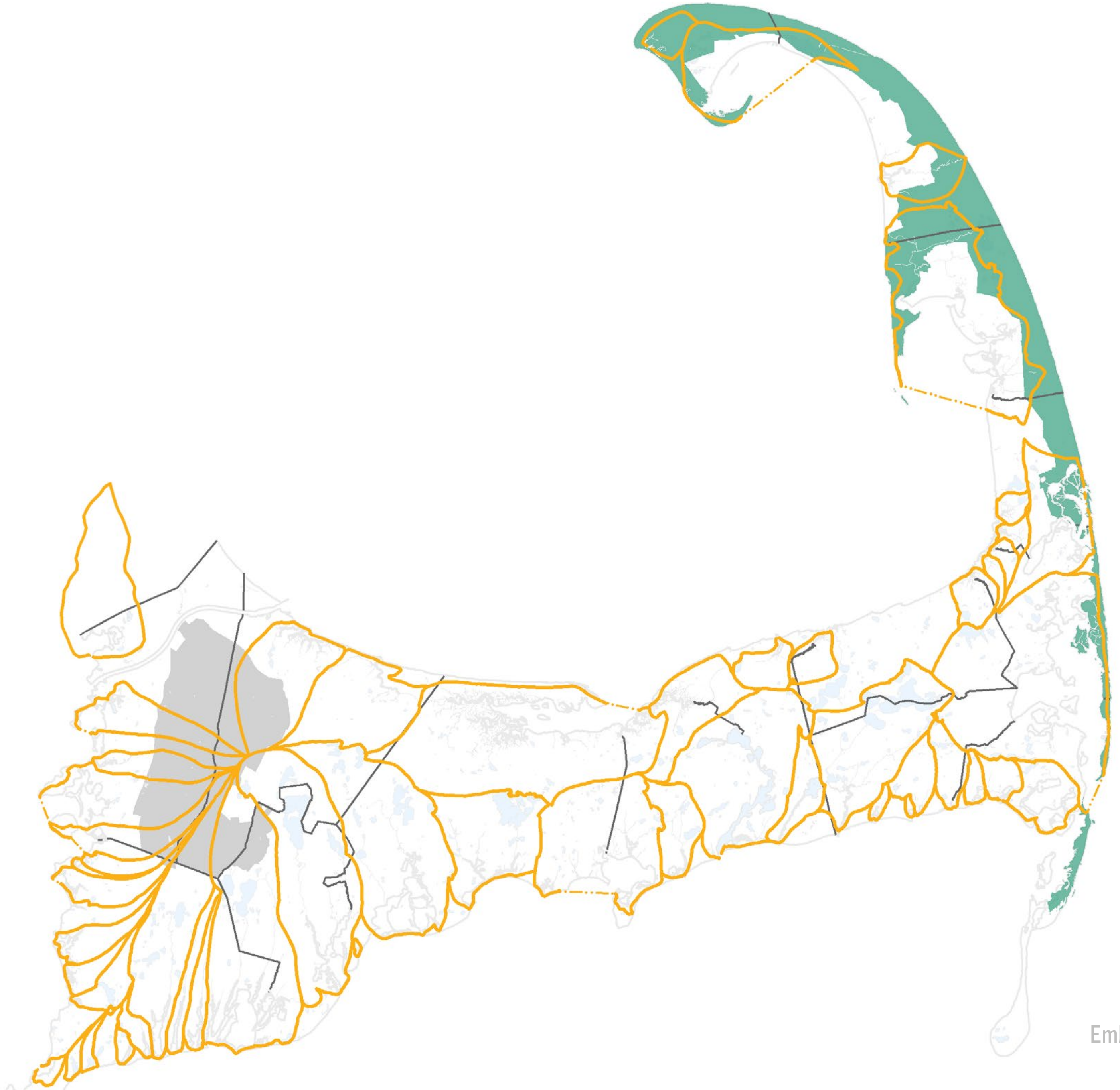
Watershed Based

Watersheds define the jurisdiction of the nitrogen problem.

A watershed is a geographic area separated from other regions by drainage divides within which all water flows to

Decision Support Tool Data

WatershedMVP utilizes updated land use and water use data to inform wastewater load calculations, nitrogen load calculations and scenario planning. See **Appendix 5A** for more information on decision support tool data.



Embayment Watersheds

Figure 5-1

Cross-Boundary Watersheds

Figure 5-2

a common outlet, such as an embayment. There are 101 watersheds that flow to the surrounding marine waters of Cape Cod. Due to the highly-permeable nature of the Cape's geology, its watersheds are delineated based upon groundwater flow and water table maps. Fifty-three are watersheds to semi-enclosed coastal embayments (see **Figure 5-1**).

The remainder flow directly to Cape Cod Bay, Nantucket Sound, Buzzards Bay or the Atlantic Ocean. The coastal embayments are located at the margin of the aquifer and are the ultimate receiver of the aquifer's groundwater discharge. The south side embayments are more heavily impacted by nutrients and pollutants within the watershed, as they are shallower and receive less tidal flushing than water bodies on the north side.

Watersheds do not follow the municipal boundaries separating one town from another. Of the 53 watersheds to coastal embayments, 32 are shared by more than one town (see **Figure 5-2**).

Many of these watersheds have established total maximum daily loads (TMDLs). See Appendix 5B for details on each watershed, including characteristics, such as size and development, contributing towns, and TMDL status.

Comprehensive wastewater management plans (CWMPs) are a key step in addressing current and future wastewater needs in order to meet TMDLs; however, CWMPs are typically completed on a town-wide basis.

A watershed approach looks at the jurisdiction of the nitrogen problem – all of the contributing sources within a watershed and the receiving water, without regard to political boundaries. As discussed in Chapter 2, estuary water quality problems on Cape Cod have been negatively impacted by increased nitrogen generated by wastewater, fertilizer and stormwater runoff as a result of development that has outpaced infrastructure.

While watersheds define the jurisdiction of the problem, wastewater planning on Cape Cod has rarely been completed on a watershed basis. Communities have had difficulty implementing town-wide CWMPs that are perceived as too expensive and inflexible. The result often orphans necessary plans to address degraded water quality in individual watersheds . Communities shouldn't have to plan to the municipal jurisdiction. This regional water quality plan provides the background to support the design of local targeted watershed plans to result in faster, better and less expensive plans that yield higher rates of implementation.

Planning jurisdictions defined only by municipal boundaries will not necessarily meet TMDLs established for shared watersheds and often results in a plan so large and so expensive that it becomes difficult for a community to commit funding. A targeted watershed approach that does not require planning within the entire municipality, but instead, focuses on addressing the entirety of a watershed becomes more manageable and directly focused on the problem.

TARGETED WATERSHEDS

Designated Waste Treatment Management Agencies (WMAs) for those watersheds designated by this plan as nitrogen-sensitive are eligible for Targeted Watershed Management Plans (TWMPs).

Targeted watershed plans will qualify for expedited review and comprehensive permits with component reduction, remediation and restoration projects eligible for funding through existing and proposed resources identified in this Section 208 Plan Update, including the State Revolving Loan Fund.

TWMPs will include baseline water quality information and a nutrient management program (NMP) identifying watershed-based solutions to nitrogen over-loading of coastal waters.

TWMPs and CWMPs will be reviewed as Capital Developments of Regional Impact reviewed for consistency with this Section 208 Plan Update and the Cape Cod Commission Act.

A new approach supporting Targeted Watershed Management Plans (TWMPs), based on watershed boundaries, is recommended.

Recommendation R5.1:
Targeted Watershed Management Plan (TWMP) guidance including minimum performance standards for nitrogen in degraded water bodies shall be drafted and issued by the Cape Cod Commission, in concert with MassDEP, pursuant to this update within 90 days of its approval.

REGIONAL OPPORTUNITIES AND ECONOMIES OF SCALE

Working at the watershed level to develop local solutions makes the most sense from an environmental perspective; solutions should be identified within the jurisdiction of the problem. However, realizing potential savings from regional approaches may assist communities in implementing solutions. The following factors influence the cost of traditional infrastructure (Cape Cod Commission 2013):

- **EXTENT OF SEWERS**: Wastewater collection costs represent about 70% of the cost of constructing a system of sewers, treatment plants, and effluent disposal facilities. Costs can be reduced by focusing on the most densely developed areas, where the least amount of sewer pipe is needed to collect wastewater flows requiring nitrogen control. A cost advantage of the watershed-based approach is the assumed greater ability to find and serve these densely developed areas regardless of town boundaries. Watershed scenarios may be combined on a subregional level where densely developed areas cross watershed boundaries
- **GROWTH**: Growth in nitrogen-sensitive watersheds carries a heavy price. While only a portion of the existing nitrogen must be removed in these areas, all of the future nitrogen load must be mitigated. A 15% growth in wastewater flow translates to a potential 20% increase in capital cost. A 30% growth potentially increases the capital cost by 40%.
- **LOCATION OF EFFLUENT DISPOSAL SITES**: Even highly-treated effluent contains some nitrogen. If effluent is disposed of within nitrogen-sensitive watersheds as opposed to non-sensitive locations, more septic systems in that watershed must be eliminated or fitted with denitrification systems to meet the TMDL. If land availability within a town dictates that effluent must be disposed of in water supply recharge areas, then a higher level of treatment is needed at sharply increased costs for both capital facilities and for operations and maintenance (O&M). Looking regionally may increase the number of potential disposal sites in non-sensitive locations.
- **ECONOMIES OF SCALE**: Cost efficiency of wastewater treatment generally increases with flows treated. Significant cost savings can accrue if Cape Cod wastewater is treated at expanded existing public facilities, with selected new facilities, as needed, compared with a larger number of smaller facilities.

  Cost savings attributed to economies of treatment must be balanced with costs of conveying wastewater from collection areas and to disposal facilities.

With funding from Barnstable County, the Town of Orleans supplemented its CWMP with a focused study of the options available to share wastewater facilities with the towns of Eastham and Brewster. The details of this evaluation are presented in the December 2009 Wastewater Regionalization Study (Orleans-Brewster-Eastham) (Wright-Pierce 2009). Compared with each town building its own separate wastewater facilities, two-town and three-town regional solutions identified potential cost savings of 6% to 9% for capital costs and 18% to 25% for O&M costs.

Consideration of shared traditional infrastructure, as well as cooperative agreements to implement non-traditional technologies, should be given full consideration in order to limit the financial burden of water quality improvements to the community.

EXPANDED OPTIONS

SCENARIO PLANNING

Disagreement about technology solutions has resulted in polarizing local debates, sometimes discussed in terms of centralized versus de-centralized approaches or traditional solutions versus alternative solutions. One of the key distinctions depends on a considered option's reliance on a permanent physical connection of multiple sources to a collection system. The scenario-building approach

presented in this report used two contrasting approaches to solving Cape Cod's nitrogen problem, a traditional approach and a non-traditional approach, as an initial means to compare technologies and their effectiveness.

Watershed scenarios are a set of possible actions and interventions to meet nitrogen TMDLs and test the effectiveness of one or more combinations of potential solutions within a watershed. "Traditional" and "non-traditional" scenarios represent the limits of these two different approaches and define the parameters within which future scenarios can be developed. Two scenarios were developed for each watershed on Cape Cod and will be available through the Cape Cod Commission's Watershed Team technical assistance program discussed later in this chapter. The scenarios developed are NOT recommended, or preferred alternatives. Rather, the scenarios:

- Demonstrate the deployment of a wide spectrum of nutrient reduction technologies available to stakeholders when considering local options;
- Serve as an example of the Section 208 Plan Update recommended methodology to analyze both traditional and non-traditional technologies before making water quality management decisions;
- Provide a valid starting point for discussions about building local consensus for water quality management planning;
- Demonstrate the range and effectiveness of tools and methods developed by the Commission to assist stakeholders in creating conceptual level plans to support consensus building; and
- Define the possible scope of an Adaptive Management Plan.

Watershed scenarios were developed by two independent teams applying the following agreed upon conditions.

- Both teams used the same identified nitrogen targets (or the amount of nitrogen, in kilograms, that a water body can receive without exceeding the TMDL), as identified in the Massachusetts Estuaries Project (MEP) technical reports and TMDL reports for individual sub-embayments.
- Both teams attempted to solve the problem within the boundaries of the watershed.
- Both the traditional and non-traditional approaches utilized siting, performance, and cost information and data from the Technologies Matrix and the Barnstable County Cost Report and used WatershedMVP and the Watershed Tracker to make decisions about collection, treatment and technology siting.
- As a mutual point of reference, the traditional team evaluated a hypothetical analysis of an "all sewer" scenario and compared it to an "all innovative/alternative (I/A) septic system" scenario. Neither was necessarily a best choice for taxpayers or the environment, suggesting scenario approaches be targeted and mixed.

Traditional Scenarios

Traditional scenarios include centralized, satellite and cluster collection and treatment technologies and maintain as many homes and businesses on Title 5 septic systems as possible. This approach provides a reliable and predictable level of nitrogen source reduction with a known cost structure. Less advantageous considerations of traditional scenarios are the high cost of constructing collection systems in low-density residential areas inability to address nutrients already in the ground water.

Non-Traditional Scenarios

Non-traditional scenarios include use of other technologies and approaches as outlined in the Technologies Matrix. Many non-traditional technologies will intercept and remediate nutrient laden groundwater, resulting in the potential for faster water quality improvement. Non-traditional technologies that intercept groundwater remediate nutrients from stormwater and fertilizers,in addition to wastewater. However, many non-traditional technologies vary widely in performance and cost. They also don't reduce the source load and can be more difficult to permit. See Chapter 4 for a more detailed discussion of benefits and drawbacks of each technology identified in the Technologies Matrix.

TRADITIONAL AND NON-TRADITIONAL SCENARIO DEVELOPMENT

TRADITIONAL APPROACH

The traditional approach considered the greatest controllable source of nitrogen (wastewater) as a percentage of the whole, identified the most efficient groupings of wastewater sources in each watershed, and suggested collection and treatment options. In developing the traditional scenarios, the present watershed nitrogen loads and the amount of necessary reductions to meet the TMDL were determined.

NON-TRADITIONAL APPROACH

The non-traditional approach started with the premise that collection systems should be avoided or minimized to the greatest extent possible. Although conventional wisdom and practice suggests that economies of scale in the construction of wastewater treatment facilities result in the least expensive and most effective treatment, there is valid concern that the case studies supporting this view are from more urban communities with existing but degraded infrastructure. Cape Cod is missing both of these qualifications, having neither the urban density characteristics nor the existing infrastructure. Cape Cod has less than 4% of the population of the state and approximately 20% of the septic systems. Only 3% of the parcels and 15% of the wastewater flows on Cape Cod are centralized.

The Cape also has an attribute not shared by other communities - its seasonal second homeowner economy. The population of Cape Cod increases from 216,000 year-round residents to nearly 650,000 or more on any given day between Memorial Day and Labor Day, hosting an average of 7.2 million people in that four-month period. Wastewater treatment facilities designed for the four weeks of potential peak flow would have a much larger capacity than needed 48 of 52 weeks a year.

Additionally, there are people in every community advocating for wastewater solutions that rely less on structural interventions, which may be less sustainable over time, than strategies that favor the modification of natural systems. The technologies and strategies prioritized in the non-traditional approach also tend to result in less movement of water between watersheds and put a greater emphasis on comprehensive system restoration or improvement.

The non-traditional team began with the same nitrogen removal target as the traditional team and began by assigning nitrogen reduction credits to the watershed for fertilizer reductions and stormwater management. The team then considered an array of watershed and in-embayment options, as detailed in the Technologies Matrix, consisting of a broad range of innovative nitrogen management strategies to intercept and treat nitrogen in the groundwater or to assimilate and treat it in the receiving waters. Watershed practices include permeable reactive barriers (PRBs), constructed wetlands, phytoremediation and fertigation wells, among others. Sites were located using the Cape-wide site screening analysis for non-traditional technologies described in Chapter 4. Embayment practices include, but are not limited to, shellfish bed restoration, aquaculture, floating wetlands, dredging and inlet modifications.

Stormwater and fertilizer constitute approximately 20% of the nitrogen load across Cape Cod and in some areas a higher percentage. The non-traditional team estimated watershed stormwater and fertilizer loads and applied a 25% reduction credit to those loads based on the adoption of management programs. Adoption of policies and development of capital projects are both recommended to achieve these levels of reduction.

For stormwater projects, certain reductions can be assumed based on site specific conditions and methods employed. Direct and untreated stormwater discharges are no longer allowed under the Massachusetts Department of Environmental Protection (MassDEP) Massachusetts Stormwater Standards and are being mitigated using a range of stormwater retrofit projects including infiltration, bioretention, vegetated swales and other low impact development (LID) practices. These retrofits will also contribute toward compliance with the emerging United States Environmental Protection Agency (US EPA) Municipal Stormwater Separate Storm Sewers (MS4) Program (discussed in Chapter 3) which will require regulated communities to address water quality impairments.

Significant efforts and accomplishments to reduce fertilizer impacts are also being instituted on Cape Cod. These include a successful program developed and instituted by the Cape Cod Golf Course Association to

reduce fertilized areas and rates that havs resulted in a reduction of approximately 50% of the applications. Similarly, a District of Critical Planning Concern (DCPC), adopted by the Cape Cod Commission in 2014, enables towns to develop regulatory programs to more carefully manage fertilizer applications, thereby reducing the rate of fertilizers leaching into the groundwater. Monitoring to prove that anticipated nutrient reductions are achieved will be required and reductions should be considered as part of the watershed adaptive management plan.

The next step in the non-traditional approach considered alternative on-site options that have been screened for geographic suitability. A number of alternative wastewater source controls were evaluated in this step. Ecotoilets are alternative toilets that target the source within the building. These include urine diversion (UD), composting, incinerating and packaging toilets where the waste materials are collected and temporarily stored before processing. These technologies allow little or no human waste to enter the septic system (only gray water from the shower, laundry and sinks). Social acceptability and significant, but improving, regulatory impediments had the team using these strategies in a targeted way (schools, for example).

The non-traditional approach produced a targeted starting point for consideration as part of an adaptive management program in most watersheds.

Together, the traditional and non-traditional approaches provide the tools and parameters around which towns within a watershed can develop locally-preferred options to meet TMDLs.

Development of these two approaches led to another distinction between technology options. Technologies and approaches can be grouped in to three categories: policy, collection, and non-collection. The primary difference between the categories lies in the need for a collection system, which is largely defined as a system for removing waste from the property, and in many cases is the most expensive component of a strategy. Locally developed plans should design watershed scenarios with an appropriate mix of technologies using a hybrid planning approach, which should be used as the basis for a NMP as part of a TWMP.

In order for expanded options to be permitted there has to be a sustainable and robust monitoring program.

TARGETED WATERSHED MANAGEMENT PLANNING - HYBRID WATERSHED APPROACH

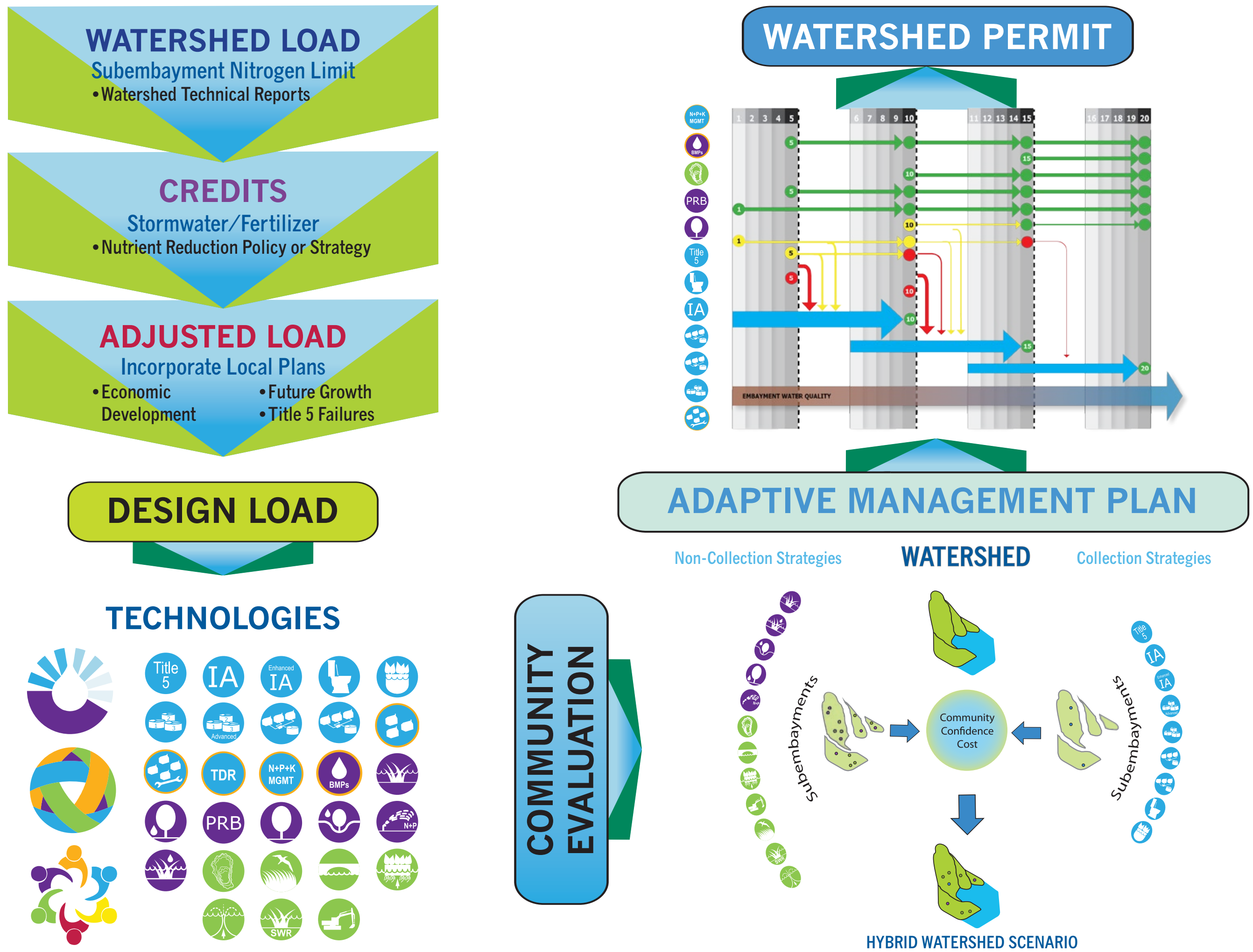
The technical review detailed above grouped technologies as "traditional" or "non-traditional." That nomenclature was specifically defined for that purpose but its continued use may unnecessarily bias future planning and regulatory efforts. In the recommended adaptive planning format the contrasting approaches are referred to as collection management and non-collection management of nitrogen.

The recommended process encourages the establishment of an agreed watershed target for nitrogen reduction and then adjusts those targets by incorporating credits for nitrogen-reducing policies and any other nitrogen impacts of local plans. Structuring contrasting approaches to meet water quality standards sets the parameters for the public discussion. A subembayment consideration of a collection scenario and a non-collection scenario with the assistance of Cape Cod Commission decision support tools will allow local decision makers to move beyond "engineering" discussions and instead focus on issue of community, cost and confidence in identifying the most efficient and effective nitrogen management plan.

This planning process begins with identified nitrogen reduction targets and then sequentially and cumulatively reduces the load to achieve those targets. Depending on the embayment impacted, this process may be most effectively done on a subembayment scale (see **Figure 5-3**).

- **IDENTIFY TARGET REDUCTIONS AND GOALS:** To determine the level of intervention necessary to restore water quality in each embayment, nitrogen reduction goals are established for each watershed. Where MEP reports have been prepared or TMDLs established the values identified are utilized. For those watersheds where these studies have not yet been completed interim targets could be utilized. A 25% reduction of existing nitrogen is assumed as a placeholder for those watersheds without MEP reports and established targets. The reduction goals

Targeted Watershed Planning



Targeted Watershed Planning

Figure 5-3

are calculated as the difference between the existing load and the target load (**reduction required (kg)= existing load – target load**).

- **ESTABLISH DESIGN LOAD:** Cape Cod towns are actively targeting stormwater and fertilizer nitrogen, among other preventative measures, and developing mitigation projects/programs to reduce their loads. These efforts should be taken as a credit towards achieving the required nitrogen reductions. Aside from water quality restoration in coastal embayments there are a number of reasons a community may want or need to provide infrastructure within a watershed. Areas that cannot comply with Title 5, due to depth to groundwater, poor soils, inadequate setbacks or lot areas, among other reasons, need new infrastructure solutions. Communities may have identified growth areas, such as village centers and growth incentive zones, where high density is anticipated. Or pond recharge areas may be significant in the watershed. A design load is the total nitrogen load to be removed after accounting for other needs of the community and is calculated as the difference between the reduction required and the credits, with the addition of the non-nitrogen community needs (**design load (kg) = reduction required (kg) – credits + non-nitrogen community needs**).
- **NON-COLLECTION MANAGEMENT OPTIONS:** A broad range of innovative and non-traditional nutrient management options evaluated as part of the non-traditional scenario to intercept and treat nutrients along their flow paths through the watershed or to assimilate and treat them in the receiving waters (embayments) should be considered.
- **COLLECTION MANAGEMENT OPTIONS:** Alternative on-site wastewater source controls, such as ecotoilets and I/A systems, should be considered first in areas where a lack of housing density coupled with a need for nitrogen reduction are present. If the cumulative nitrogen reductions following the use of these source controls and the non-collection options have not achieved the required reduction then collection and treatment in these areas may be necessary.

This iterative process of comparing technologies based on available sites, cost efficiency and performance in a phased manner with community input allows consideration of “right-sized” infrastructure. It is recommended that targeted watershed planning efforts adopt this hybrid approach.

Recommendation S5.2:
Targeted watershed planning efforts shall adopt a hybrid watershed scenario planning process.

MONITORING

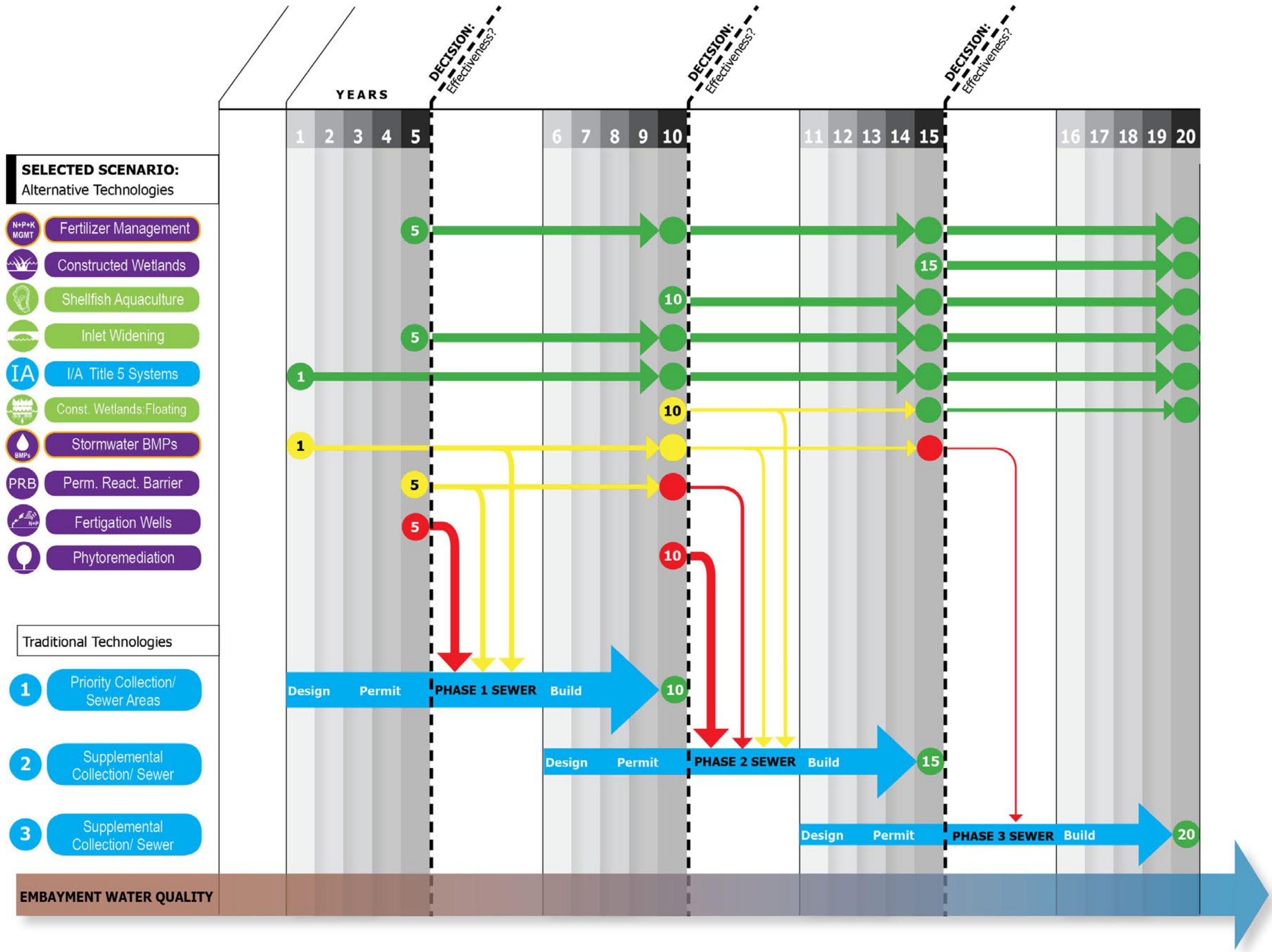
Monitoring is crucial to measure progress toward meeting water quality goals; it will provide baseline metrics for evaluating technology performance (pilot testing), TMDL compliance of the implemented solution, and adaptation of the hybrid plan to optimize TMDL compliance. Both performance monitoring and water quality monitoring will be necessary to determine success of individual technologies and changes in water quality. See Chapter 4 for more detailed information on monitoring.

ADAPTIVE MANAGEMENT

Adaptive management provides a framework to move forward efficiently with practices that can generate short-term results, and allow for adjustments to optimize the plan over the implementation period (see **Figure 5-4**). The proposed adaptive management framework enables a thorough vetting of new technologies while maintaining a secure foundation of proven traditional technologies. The plan provides a thoughtful process for integrating emerging and non-traditional technologies with traditional practices concurrently in watershed plans.

Applying this approach, each TWMP that is developed will have an adaptive management plan to condition its approval, with specific milestones and reporting.

Each TWMP will include a set of traditional and non-traditional practices assembled to meet identified nutrient reduction targets and desired water quality goals. Traditional technologies may best serve densely developed town centers, while non-traditional technologies may be applied in water bodies for short term water quality improvements. The adaptive management process provides a means to optimize this combination of technologies.



Adaptive Management Framework

Figure 5-4

In some watersheds a traditional sewering plan may be identified for construction during the first phase of implementation. Future expansion, or phases, of this core collection system will be part of the initial wastewater management planning, and will serve as the backup plan for future phases of the watershed plan in the event that the non-traditional practices do not perform adequately.

As discussed in Chapter 4, piloting some of the alternative technologies that show particular promise for remediating Cape Cod water quality problems is needed to establish performance of these technologies. In cases where pilots suggest that a technology will not perform as hoped, the adaptive management plan will identify a back-up strategy using more certain approaches that will lead to water quality improvement.

This adaptive management framework is structured in five year increments. This timeframe enables two years for the design, permitting and construction of technologies along with a minimum three year testing period. At the completion of each five year period, an evaluation of the performance of deployed technologies takes place. These assessments will include the achieved nutrient removal performance, cost effectiveness, and any associated co-benefits.

Technologies that meet the identified objectives can continue to be used and additional installations may be implemented in the watershed. In instances where partial success is realized, an evaluation of possible adjustments and improvements takes place and, if deemed appropriate, continued application of that technology may occur. Where poor performance is realized, further application of that technology will be discontinued or modified within that watershed.

Essential to the successful implementation of a TWMP is comprehensive monitoring of water quality within sensitive water bodies. Overall water quality improvements at the established MEP sentinel stations will need to be evaluated. This information will be integrated with the technology performance to determine next steps in the implementation of the watershed plan.

In recognition of the complexity associated with implementing a monitoring and adaptive management plan, the following components are recommended for inclusion and should be incorporated into Commission and MassDEP approvals and permits. These components include but are not limited to:

- Establishment of a technical review panel to meet regularly and comprised of local, regional and state representatives
- Pilot project design, development and monitoring
- Targeted watershed project funding, design, construction, and permit compliance
- Compliance monitoring including baseline water quality and habitat monitoring for estuaries

EMPOWER COMMUNITIES

Community Engagement is more than a box to check when developing a plan. Taking it seriously means making complex data sets easier for citizens to understand and use in local decision-making.

WATERSHED TEAMS

Municipalities are encouraged to consult with the Commission to ensure coordination between active watershed planning efforts and the Section 208 Plan Update and to establish consistency between proposed municipal plans and the Section 208 Plan Update with respect to the evaluation of wastewater needs, watershed management alternatives and alternatives analyses. The Commission will assign a Watershed Team to the specific planning efforts to assist with the decision support tools, permitting of technologies and financing.

Recommendation S5.3: The Cape Cod Commission shall assign Watershed Teams to provide technical assistance to Waste Treatment Management Agencies (WMAs) and municipalities.

COMPOSITION

Watershed teams may include experts in water resources, GIS, land use and economic development planning, finance modeling, legal/regulatory, technologies, and facilitation.

Water resources experts include hydrologists and engineers with extensive experience in Cape Cod's unique hydrogeology and water quality challenges. They can assist in developing targeted watershed plans by applying Watershed MVP and the Watershed Tracker, and can evaluate site-specific nutrient mitigation projects using groundwater modeling, and nutrient loading and mitigation assessments.

GIS analysts have direct access to the most current databases and are directly involved in the continual development and updating of GIS-based analytical programs such as Watershed MVP. They can provide screening for potential nutrient management sites, apply a GIS technology viewer that is designed to track and illustrate watershed management scenarios, and can optimize collection areas based upon an integrated density-frontage-proximity algorithm.

Land use planners are involved in updates to the Regional Policy Plan (RPP), local comprehensive plans, establishment of Critical Planning Areas of Concern, and conduct Regional Economic Strategy Executive Team (RESET) projects. They can advise on consistency of watershed plans with the RPP, buildout scenarios and related land use issues.

Legal and regulatory experts work closely with MassDEP and US EPA regulatory staff and are very familiar with the Section 208 consistency requirements. They can provide assistance with permitting, Massachusetts Environmental Policy Act (MEPA) compliance, regional arrangements, and the development and implementation of an adaptive management plan.

Non-traditional technology experts are directly involved in the state-of-the-art research (including performance and costs) on a broad range of green infrastructure and non-traditional technologies. They can provide assistance in selecting, siting, evaluating non-traditional/green infrastructure technologies, and in the application of Technologies Matrix and Watershed Calculator.

Facilitators have served a critical role in the successful development of the Section 208 Plan Update. They can assist the WMA with consensus building, public engagement and outreach and overall project management.

ROLE

The role of the Watershed Team is to provide assistance to communities in developing an effective local watershed restoration and management plan in compliance with the Section 208 Plan Update. The Watershed Team will work with towns, identified stakeholders and third-party consultants to develop an integrated hybrid plan that addresses identified water quality restoration goals and incorporates local preferences. Specifically, the Watershed Team can assist in developing a step-by-step approach to building a locally-supported watershed strategy. Specific tasks that the Watershed Team can assist with include:

- Developing a watershed plan outline, tasks and schedule including a consensus-building process and a public engagement strategy
- Developing a scope of services for a third-party contractor to provide specific engineering tasks necessary to compliment the Watershed Team
- Presenting Section 208 watershed plans to identify a range of options potentially-available to address the nutrient reduction goals
- Explaining and applying analytical tools including Watershed MVP, the Watershed Tracker, the Technologies Matrix and the Watershed Calculator
- Assisting in the development of a hybrid plan by providing recommendations for green infrastructure/non-traditional practices and traditional sewer collection systems
- Working with the WMA, stakeholders and third-party contractor to evaluate the feasibility of individual Hybrid Plan components using site-specific data and local knowledge
- Identifying and evaluating potential public/private options such as satellite wastewater treatment systems
- Working with the third-party contractor in developing comparative cost information

- Assisting in the development of permitting strategies
- Developing targeted monitoring plan and associated adaptive management

BENEFITS

Utilizing a Watershed Team positions a community to align their watershed planning efforts with the Section 208 Plan Update early in the process. There should be benefits to this approach. Benefits to a community utilizing this resource fall in to three categories:

- Technical Assistance
- Regulatory Flexibility
- Financial Resources

The Watershed Team provides interdisciplinary, watershed specific technical assistance, creating a clear path toward consistency with the Section 208 Plan Update. With consistent communication with a Watershed Team from the outset, communities should be able to bypass some of the regulatory review that would otherwise be required. As described in Chapter 3, it is recommended that the 2015 Update to the Regional Policy Plan (RPP) include a consideration for Capital Developments of Regional Impact (CDRIs), which would exempt capital planning projects, such as TWMPs, that have been deemed consistent with another regional plan from DRI review. Consistency with the Section 208 Plan Update and a CDRI certificate should allow communities access to new sources of revenue that are made available to the region (see Chapter 6 for a more detailed discussion on revenue).

Recommendation C5.4: Local targeted watershed management plans consistent with the Section 208 Plan Update should qualify for existing and potential revenue sources.

WATER RESOURCE CENTER

With decision making, project sponsorship and operations based at the local level, there remain certain activities and functions that, managed regionally, would benefit municipal operations, attract resources and lower costs to residents. Four specific functions: financing, monitoring, scenario analysis and septic management would all become cheaper and more beneficial in a regional service center than if left to the individual communities.

Enhanced or new authority would be needed to establish the capability to operationalize these services, but the descriptions below provide a brief synopsis of their potential:

1. Financing: A regionally-based financing capability would offer towns the option to seek financing from a regional entity rather than extend the town's full faith a credit as is currently required. A regional financing entity could be eligible for State Revolving Fund (SRF) loans and also attract additional funds to increase community access to additional subsidy. Financing through such an entity would preserve the town's full faith and credit for use in other municipal projects and would enable towns to proceed with projects based upon majority action by the voters of each respective community.
2. Monitoring: Adaptive management, as envisioned in this plan, relies on a robust program of water quality monitoring both pre and post implementation. The procurement of sentinel station monitoring of all embayments and near shore stations will lower the overall cost of monitoring while also relieving towns of a major and ongoing expense. An additional benefit of a unified approach to monitoring is the ability to ensure easy and consistent availability of monitoring results to the communities and the general public.
3. Scenario Analysis: As a part of the Section 208 Plan Update process the Commission has developed leading edge capabilities to analyze the outcomes and water quality implications of differing nitrogen management scenarios. The ability of communities to assess the costs and benefits of different alternatives will enhance local decision making and provide a low/no cost capability that would otherwise have to be procured by towns at great local expense.
4. Septic Management: Integral to the cost control strategy of this plan is the retention of as many existing septic systems as possible. Extending the useful life of septic systems to be retained will both lower and spread out the costs associated with system replacement. The scheduled pumping and maintenance of systems will also allow for the

5

optimization of the use of septage treatment. The current system relies exclusively on homeowners to properly maintain systems and also leaves them at risk of the high cost of replacement should a system abruptly fail.

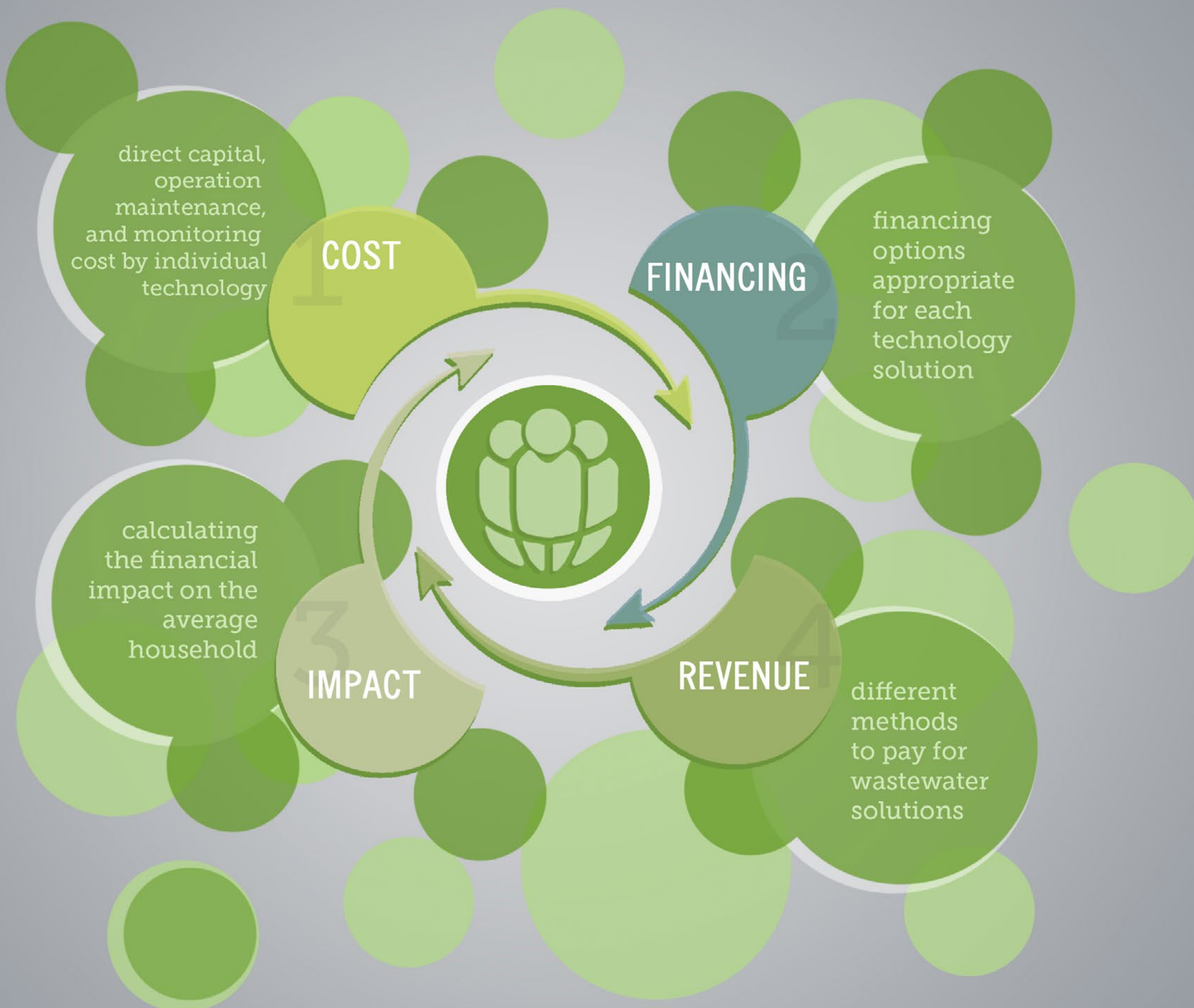
The institution of a regionally-based program that would ensure proper pump out and maintenance as well as providing replacement services would have the multiple benefits of extending the life of existing systems, controlling the flow of septage to treatment plants and protect homeowners from exposure to financial hardship associated with system failure. Such a system could be established based upon an annual septic fee that would cover the cost of pump out as well as replacement.

06 MONEY

Cost & Financial Affordability

A primary goal of this plan is to lower the cost of meeting water quality standards and spread the remaining costs equitably among all who enjoy and benefit from Cape Cod. In a region that has largely deferred and avoided the cost of necessary wastewater management, residents are appropriately sensitive to costs. The high cost of traditional approaches has been a major impediment to wastewater planning and implementation on Cape Cod.

Of particular concern to the region is its large seasonal fluctuation in population and wastewater flows. The need to accommodate the large flows experienced over a brief four week period – the last two weeks of July and first two weeks of August – creates an additional burden on the smaller year-round population.


direct capital, operation maintenance, and monitoring cost by individual technology
1
COST
FINANCING
2
financing options appropriate for each technology solution
calculating the financial impact on the average household
3
IMPACT
REVENUE
4
different methods to pay for wastewater solutions

MONEY

Chapter 6: Cost & Financial Affordability

The Cape Cod Economy

The Cape Cod economy is heavily seasonal with more than one third of its gross regional product (GRP) coming from tourism-related industries. With the arrival of second home owners and summer tourists, the population more than doubles at any given time in July and August. The region's infrastructure, including wastewater infrastructure, must be scaled to handle this population peak of approximately 650,000 people.

The GRP for Cape Cod hovers between $7 and $7.5 billion a year (between 1.5% and 2% of the gross state product). Significant portions of the GRP come from retail trade, real estate and rental activities, and accommodation and food service. Wages in these industries are generally low, and wages in Barnstable County lag behind the state and the nation. Moreover, Barnstable County is below the state median income, at $60,685, and wages have not grown in real terms since 1990.

The current (2014) equalized evaluation of property values for property tax purposes on Cape Cod is $77.8 billion for all 15 towns combined. The total property taxes collected (the levy) in 2014 was $615 million with an average single family tax bill of about $4,000 a year. In comparison, the average annual single family tax bill in Massachusetts is nearly $5,000.

A recent study by the Cape Cod Commission on the Three Bays watershed in Barnstable showed that a decline in water quality results in lower property values (http://www.capecodcommission.org/3bays/). Given the way property tax works, a reduction in coastal property values due to poor water quality will shift the tax burden to those with property away from the water and less able to absorb increased taxes not associated with any water quality improvement.

Image on Facing Page: Topics addressed in this chapter can be grouped in to four categories – the total cost of the solution, how to finance solution, how to pay for the solution, and how to address the financial impact on individual households.

Estimated Cost and Affordability

Just as Cape Cod's watersheds have a finite capacity to absorb nitrogen, the Cape's property owners have finite financial resources to implement solutions to address water quality impairments. The estimates for solving the Cape-wide problem through traditional centralized treatment, whether working town-by-town or watershed-by-watershed, range from $4.2 to $6.2 billion (Cape Cod Commission 2013). If paid through property tax betterments and user fees, the cost of such a traditional approach exceeds the United States Environmental Protection Agency (US EPA) affordability standard of 2% of median income being allocated to wastewater solutions. It's also important to note that the 2013 median income for Massachusetts is $62,963, leaving Cape Cod residents (median household income is $60,685), on average, less able to afford necessary wastewater infrastructure than other state residents.

Property owners on Cape Cod will not bear the burden equally, although most contribute to the problem and all

will benefit from its resolution. Much will depend on how the solutions are financed and what sources of funding can be employed. The challenge is to equitably and fairly spread costs among all who enjoy Cape Cod, from the year-round resident to the second homeowner to the tourist visiting for a week or a day. Just as this plan has advocated considering a variety of water quality solutions, it encourages consideration of many different revenue sources available at the federal, state, regional and local levels. A goal of the Section 208 Plan Update is to reach a common understanding that the burden of funding needs to be shared by everyone who benefits from a healthy Cape Cod environment.

This plan strongly encourages collaboration among towns to address the nutrient problem in the shared watersheds across the Cape. Conservative estimates from the Regional Wastewater Management Plan suggest that shared infrastructure and economies of scale could result in a savings of up to 9% on capital/construction costs and up to 25% on annual operations and maintenance costs (Cape Cod Commission 2013). This plan also encourages collaboration at the local, regional and state level to implement land use policies that focus future growth in those areas where wastewater treatment exists or can be constructed for the lowest cost and serve the greatest number.

Watershed Plan Cost Categories

PLANNING & DESIGN COSTS

Planning and design costs are incurred prior to any construction. Towns may access funds from the State Revolving Loan Fund (SRF) to support wastewater or watershed planning but much of the design must be covered using local funding sources.

CAPITAL COSTS

Capital costs are those incurred in the construction of any type of treatment system, including traditional collection and treatment technologies and non-traditional technologies, such as permeable reactive barriers or constructed wetlands. Capital costs are generally financed through borrowing, although some limited grant opportunities exist to lower the amount to be financed.

OPERATION AND MAINTENANCE COSTS

Operation and Maintenance (O&M) costs are the annual recurring costs of nutrient interventions, including nontraditional technologies, and keeping them in working order. O&M is generally paid for through fees or tax revenues as costs accrue. These costs are generally not financed using loan or bonding programs. O&M costs will vary greatly by technology solution and are estimated on a technology-by-technology basis in the Section 208 Plan Update Water Quality Technologies Matrix (Technologies Matrix), discussed in Chapter 4.

MONITORING COSTS

Monitoring is an essential component of adaptive management. Monitoring will assess the effectiveness of the different technologies at removing nutrients from the watershed. The results of monitoring will indicate which technologies are working and which are less successful. Permitted discharges are always required to undertake discharge monitoring and new technologies being piloted will also be required to monitor to determine actual performance.

In addition to monitoring of individual systems or management measures, baseline water quality will also be monitored to understand how marine systems are responding to the suite of management measures being implemented. The cost of this monitoring is significant, but small when compared to the potential savings in investment in unnecessary management measures should monitoring not have undertaken. Monitoring costs are typically considered an operating expense and paid for as they are incurred.

One way to manage costs is to consolidate the monitoring of sentinel stations around Cape Cod. Both the Section 208 Plan Update Technologies Panel and Monitoring Committee identified the need to establish a process and structure

for reporting and maintaining data in a consistent and centralized location as two major issues associated with monitoring and compliance.

Mandating monitoring at the town level puts a financial burden on towns that, in some cases, may make implementation infeasible. In addition, monitoring at the local level allows for inconsistencies in sample collection, analysis and distribution.

The appropriate scale for monitoring and maintaining monitoring data is at the regional scale. The Commission's Strategic Information Office (SIO) currently maintains an expansive data warehouse, and the Commission's Watershed Management Program maintains a regional historic warehouse of water resources information on behalf of Barnstable County and the 15 towns. Data hosting and maintenance would be available for a robust monitoring program providing consistent and accurate data feedback loops among the towns and appropriate agencies. Chapter 4 recommends that Barnstable County assume responsibility for monitoring and maintaining regionally consistent data sets that are freely accessible to the public. Maintaining data in a centralized, accessible location will allow information to transfer from one project to another, and assist the region in prioritizing projects based on water quality improvements and/or further degradation. In addition, designating a single responsible party for monitoring will allow for efficiencies and economies of scale in purchasing equipment and managing data. The program should be developed in conjunction with the Massachusetts Department of Environmental Protection (MassDEP) to ensure consistency in water quality assessments.

There is currently an effort underway by the Cape Cod Water Protection Collaborative to coordinate local sampling with an appropriate regionally procured laboratory(ies) for analysis. The Collaborative is seeking state matching funds to allow for a single procurement to provide ambient water quality sampling at the base stations all around Cape Cod. Data hosting and data accessibility should be through the SIO at the Cape Cod Commission. Regional technical assistance to provide data interpretation, assistance and outreach on watershed assessments and monitoring programs for Total Maximum Daily Load (TMDL) compliance and performance monitoring would provide communities with necessary information to move forward with their adaptive management plans.

Financing a Watershed Plan

Municipal finance limits the options available to communities looking to finance wastewater implementation. The vast majority of municipal revenue comes from two sources – local property tax assessments and state aid. Property tax collection operates under the constraints of Proposition 2 ½ – a voter-adopted law that limits the ability of a town to increase taxes beyond 2.5% annually without specific voter approval. This represents a barrier that has acted as a brake on municipal spending, especially on large capital projects. State aid is a critical piece of the municipal revenue picture but is subject to the vagaries of the state budget process and is based on a formula heavily weighted on property valuation, a disadvantageous approach for Cape Cod and other coastal communities.

Levy collections can increase above the legal limit specified by Proposition 2 ½ one of two ways. Voters may elect to override the limit by an amount in excess of 2.5% through a ballot question. An override provides a permanent and lasting increase in the amount of money a town may raise in property taxes and is a non-specific increase that can be expended on any municipal function. Debt exclusion allows for a temporary increase in tax collections that is earmarked to pay off the debt associated with the bonding of a specific capital expenditure. The tax increase expires once the bond payments associated with the project are paid off. The use of debt exclusions is most commonly associated with large capital projects, such as those associated with wastewater. Debt exclusion typically requires two steps, a local town meeting or town council vote, by a 2/3 majority, to authorize a borrowing and then a town-wide simple majority ballot question on the debt exclusion question. Some towns have room within their municipal levy limit to borrow inside the constraints of Proposition 2 ½ and do not need to obtain voter authorization beyond the vote to incur debt. Most wastewater infrastructure is too expensive to pay for in cash without borrowing; it must be financed over a long period of time during which revenues may be collected to pay for it. This section outlines several borrowing mechanisms available to municipalities:

- State Revolving Loan Fund,

- Rural Development loans from the US Department of Agriculture (USDA) and
- Conventional municipal financing.

Massachusetts also provides District Improvement Financing and the Local Infrastructure Development Program to help municipalities finance infrastructure development. All of these tools are described in more detail below. Each has its own cost, loan duration, use limitations and interest rate.

STATE REVOLVING LOAN FUND

The Massachusetts State Revolving Loan Fund (SRF) is a self-perpetuating loan fund administered by the State under the direction of the US EPA. The SRF program provides a low-cost funding mechanism to assist municipalities in complying with federal and state water quality requirements. The SRF program was originally funded by an act of Congress in 1987 as part of the implementation of the Clean Water Act and coincided with the decision stop providing federal capital grants to communities to build infrastructure. It is jointly administered by the Division of Municipal Services of the MassDEP and the Massachusetts Clean Water Trust (Trust). The state has two SRF programs, one for clean water and another for drinking water, which are administered by MassDEP. The clean water SRF may be used for planning or construction of wastewater and stormwater management systems. Eligible uses are outlined in the MassDEP regulations at http://www.mass.gov/eea/agencies/massdep/water/grants/state-revolving-fund.html. SRF loans vary by interest rate depending on the duration of the loan and locally-adopted regulations to manage growth after construction of the wastewater system.

Each year MassDEP solicits projects from Massachusetts municipalities and wastewater districts to be considered for subsidized loans. The current subsidy is provided via a 2% interest loan or, under certain growth-neutral criteria, 0% financing. Loans may be forgiven or partially forgiven. In recent years the program has operated with $300 to $350 million per year, representing the financing of 50 to 70 projects annually. The SRF Program continues to emphasize watershed management priorities. A major goal of the program is to provide incentives to communities to undertake projects with meaningful water quality and public health benefits and that address the needs of the communities and the watersheds.

Comprehensive Wastewater Management Plans (CWMPs) do currently have an advantage in receiving SRF funds.

ELIGIBLE PROJECTS

Financial assistance from the SRF is available for planning and construction of projects, including:

- combined sewer overflow (CSO) mitigation;
- new wastewater treatment facilities and upgrades of existing facilities;
- infiltration/inflow correction;
- wastewater collection systems;
- nonpoint source pollution abatement projects (e.g. landfill capping);
- community programs for upgrading septic systems (Title 5);
- brownfield remediation;
- pollution prevention;
- stormwater remediation;
- and climate change adaptation (e.g. stream bank stabilization and berms).

In addition, non-structural projects are eligible for SRF funding, such as planning projects for nonpoint source problems which are consistent with the MassDEP's Nonpoint Source Management Plan and that identify pollution sources and suggest potential remediation strategies.

For details on the application process see Appendix 6A.

On August 6, 2014, a bill aimed at "improving drinking water and wastewater infrastructure" was signed by the Governor as Chapter 259 of the Acts of 2014. The new law creates another form of financial assistance for communities with SRF loans - principal forgiveness. The Clean Water Trust, the entity that awards SRF loans, is now able to offer principal forgiveness so long as that subsidy does not exceed 25% of the total cost of all projects for the year, and does not exceed the equivalent of a 75% subsidy compared to a market rate loan.

The law also details how MassDEP may establish who is eligible for principal forgiveness. The project must satisfy one of the following criteria:

1. pursuant to an adopted regional wastewater management plan;
2. connects a local or regional government unit to a Massachusetts Water Resources Authority facility;
3. is a green infrastructure project, as defined in the bill;
4. uses regional water resources to offset local impacts of water withdrawals in the watershed basin of the receiving community;
5. is a direct result of a disaster subject to a declaration of emergency;
6. provides public water supply to consumers with contaminated groundwater or wells; or
7. uses innovative technology to improve drinking water infrastructure.

This plan recommends MassDEP exercise its discretion in providing principal forgiveness up to 25%.

Recommendation C6.1:
MassDEP should exercise its discretion in providing principal forgiveness up to 25%.

USDA RURAL DEVELOPMENT LOAN PROGRAMS

The United States Department of Agriculture (USDA) offers loans for water and wastewater disposal systems in rural areas and towns with populations below 10,000 and a median household income that meets certain guidelines. Funds may be used for "land acquisition, legal fees, engineering fees, capitalized interest, equipment, initial operation and maintenance costs, project contingencies, and any other cost that is determined by the Rural Development to be necessary for the completion of the project" (for more information visit: http://www.rurdev.usda.gov/UWP-dispdirectloansgrants.htm). The maximum loan term is 40 years and the interest rate is determined when the loan is negotiated.

CONVENTIONAL MUNICIPAL FINANCING

Conventional municipal financing occurs when a community uses its own full faith and credit to borrow money. A stand-alone bond sale relies on the bond rating of the community, which can create great variability in the interest rate paid. Many communities have limited bonding capacity and may have difficulty self-financing major capital wastewater infrastructure.

In addition to the local borrowing options described earlier in this chapter, Massachusetts offers two other programs that work with conventional financing – District Improvement Financing and Chapter 23L.

District Improvement Financing (DIF) allows the town to designate an area within which new property tax revenues generated from development may be used to pay off bonds issued to build public infrastructure, including sewer, which enables new development to occur.

Chapter 23L is a tax-exempt bonding program enabled through a public-private partnership to build public infrastructure improvements associated with a large development. In this case, the debt service is paid by a special property tax assessment, much like a betterment, that remains with the property if the property changes hands.

Paying for a Watershed Plan

While constructing wastewater treatment facilities is financed through loans and bonds, the incurred debt must be paid for with taxes, fees, unrestricted local aid from the state and grants. Such sources of funds are available at the local, state and federal level. The Section 208 Plan Update also recommends some additional methods for paying the cost of addressing the Cape's nutrient problem. The section below reviews a range of possible payment options that could be considered, but is not intended to be inclusive of all potential funding options.

LOCAL REVENUE

Local options to pay for the management of wastewater and stormwater fall into two categories: taxes and fees. Tax revenues may come from property taxes or local option

taxes, such as meals or room occupancy taxes. Betterments are a hybrid of taxes and fees and are assessed on properties that will be improved through the provision of public infrastructure. This method can be applied to traditional sewer or, potentially, other traditional and non-traditional water quality remediation methods that provide a direct benefit to an abutting property. Fees are payments for specific services such as the provision of water, electricity, or in this case, wastewater treatment. Fees are generally used to pay for the operation and maintenance of services being provided.

TAX OPTIONS

In Massachusetts and as described above, the main source of local revenue is property taxes. However, there are betterments as well as two local option taxes: meals tax and room occupancy tax. Other states have local option income taxes and local sales taxes, among others.

Property Tax

Taxes are broadly collected, based on property valuation and used to fund general services that benefit all taxpayers, whether they are direct users of a service or benefit indirectly through a stronger community and economy.

Property Tax Betterment

Property tax betterments are traditionally used to help pay for public water and sewer and road construction. Betterments are paid by property owners whose properties are bettered by public investment in infrastructure such as water or sewer service. The justification for such an assessment is that the market value of the property has increased for the owner as the result of a publicly-funded improvement. The betterment assessment transfers this market benefit back to the public from the property owner and is collected on tax bills. Betterments are used to pay for construction, but cannot be used to pay for the operation or regular maintenance of water or sewer systems.

Local Option Taxes

Massachusetts offers a local option tax on meals and a local option tax on room occupancy. Every town on Cape Cod has adopted the local option rooms tax and all but two towns have adopted the local meals tax (see **Table 6-1**). The Commonwealth does not restrict how these funds may be used. The town of Barnstable sought and received Special Legislation to have its 0.75% meals tax and 2% additional rooms tax (both made available in 2010) automatically flow to a dedicated Wastewater Infrastructure Fund to defray future costs.

	MEALS LOCAL OPTION		ROOMS LOCAL OPTION	
Municipality	**Local Tax Rate**	**Effective Date**	**Local Tax Rate**	**Effective Date**
Barnstable	0.75%	10/1/2010	6.00%	10/1/2010
Bourne	0.75%	7/1/2014	4.00%	7/1/1986
Brewster	0.75%	7/1/2010	6.00%	7/1/2010
Chatham	0.75%	7/1/2011	4.00%	7/1/1988
Dennis	0.75%	7/1/2010	4.00%	4/1/1987
Eastham			4.00%	1/1/1987
Falmouth	0.75%	1/1/2011	4.00%	1/1/1987
Harwich	0.75%	7/1/2010	4.00%	1/1/1987
Mashpee			4.00%	10/1/1986
Orleans	0.75%	7/1/2010	4.00%	4/1/1988
Provincetown	0.75%	7/1/2010	6.00%	7/1/2010
Sandwich	0.75%	7/1/2013	4.00%	7/1/1986
Truro	0.75%	7/1/2011	4.00%	12/1/1985
Wellfleet	0.75%	1/1/2010	4.00%	7/1/1986
Yarmouth	0.75%	7/1/2010	6.00%	7/1/2010

Local Option Meals Tax and Room Occupancy Tax Acceptance

Table 6-1

FEES

Fees are for direct services received such as the provision of water or other utility services and for licenses. In the context of wastewater, they may be used to fund the cost of operating, maintaining or constructing a wastewater management system.

STATE REVENUE

State revenue will likely come in the form of grants and lower interest rates on loans. Grants are outright support while lower interest rates save in the overall cost of servicing the debt incurred in building a system.

MASSWORKS GRANTS

The MassWorks Infrastructure Program provides grants for publicly owned infrastructure including but not limited to: sewers, utility extensions, streets, roads, curb-cuts, parking facilities, site preparation and improvements on publicly owned land, demolition, pedestrian walkways and water treatment systems to support three project types:

- Housing development at a density of at least four units to the acre (both market and affordable units);
- Transportation improvements to enhance safety in small, rural communities;
- Economic development and job creation and retention.

Applications are accepted once a year from municipalities and other eligible public entities.

FEDERAL CLEAN WATER ACT 604(B) WATER QUALITY PLANNING GRANTS

The Federal 604(b) Water Quality Planning Grants are administered by MassDEP. The grants may be used for watershed- or sub-watershed-based nonpoint source assessment and planning projects leading to the: 1) determination of the nature, extent and causes of water quality problems; 2) assessment of impacts and determination of pollutant loads reductions necessary to meet water quality standards; 3) development of green infrastructure projects that manage wet weather to maintain or restore natural hydrology; and 4) development of assessments, preliminary designs and implementation plans that will address water quality impairments in impaired watersheds.

During the course of the Section 208 Plan Update, several new funding sources became available to towns taking action to address nitrogen impacts in their watersheds.

STATE CAPITAL SPENDING PLAN

On August 13, 2014, the governor signed a $2.2 billion environmental bond bill into law, the largest in Massachusetts's history. The bond bill authorizes the State to fund projects that evaluate, protect and improve its environmental resources. Funding is now authorized for maintaining water quality, enhancing coastal infrastructure, managing waste, and supporting local fisheries and agriculture, among other programs. However, these types of projects must be included in the governor's annual Capital Spending Plan to be made available to Cape communities.

As part of an investment in Massachusetts' water quality, $4 million is authorized for monitoring programs, specifically to implement and evaluate adaptive management as it relates to the reduction of nitrogen pollution in coastal waters. The County is developing a strategy to partner with the Commonwealth to make this $4 million available to monitor water quality in locations where adaptive management is implemented.

An additional $4.5 million is authorized to be invested in pilot projects that aim to restore water quality of degraded estuaries in pursuit of TMDL compliance. The funding is designated for "innovative and green wastewater management technologies and approaches," including constructed wetlands, aquaculture, permeable reactive barriers, ecotoilets, and other technologies listed in the Technologies Matrix. The $4.5 million could also be spent on the installation of sustainable technologies at wastewater treatment facilities, such as co-digestion and resource recovery, that will target regional needs.

Both investments require monitoring programs and pilot projects to be "consistent with a current area-wide water resource management plan adopted under Section 208 of the Federal Clean Water Act."

The Commonwealth of Massachusetts should make funds designated for monitoring programs and pilot projects available to Cape Cod for efforts that are consistent with the Section 208 Plan Update.

Recommendation C6.2: The Commonwealth of Massachusetts should make funds designated for monitoring programs and pilot projects available to Cape Cod for efforts that are consistent with the Section 208 Plan Update.

FEDERAL FUNDING

Similar to state funding, federal support will likely be found through grant programs or loan forgiveness programs for construction.

USDA GRANTS

The purpose of USDA grants is to develop water and waste disposal systems in rural areas and towns with populations not in excess of 10,000. The funds are available to public bodies, non-profit corporations and Indian tribes. To qualify, applicants must be unable to obtain the financing from other sources at rates and terms they can afford and/or their own resources. There are some systems that qualify for grant funding; however, grant funding availability is limited. Program details are available on the USDA website: http://www.rurdev.usda.gov/UWP-dispdirectloansgrants.htm.

US ECONOMIC DEVELOPMENT ADMINISTRATION (EDA) GRANTS

EDA grants are meant to support the development and implementation of economic development strategies for economically distressed communities. Funding priorities are given to investment applications that support long-term, coordinated and collaborative regional economic development approaches; innovation and competitiveness; entrepreneurship; and strategies and investments that connect regional economies with the worldwide marketplace. Additional consideration will be given to investment applications that respond to sudden and severe economic dislocations, including natural disasters; enable the transition of Base Realignment and Closure (BRAC) impacted communities; support EO 13287, Preserve America; and promote the revitalization of brownfields. EDA grants may be used to pay for the design phase of capital construction projects. Awards are between $500,000 and $5 million, the larger size being very rare. Applications are accepted on a rolling basis.

HUD COMMUNITY DEVELOPMENT BLOCK GRANTS

Community Development Block Grants (CDBG) may be used to finance wastewater infrastructure. The CDBG Program is administered by the United States Department of Housing and Urban Development (HUD) in partnership with municipalities above a certain size and for other communities through the states. No less than 70% of CDBG funds must be used for projects that directly benefit low- and moderate-income persons. To be eligible, projects must also meet one of three national objectives: benefit low- and moderate-income persons, prevent or eliminate slums or blight, or address community development needs having a particular urgency because existing conditions pose a serious and immediate threat to the health or welfare of the community for which other funding is not available. CDBG funds may be used to build or expand wastewater infrastructure. They may not be used to defray repair, maintenance, or operating costs. The towns of Barnstable and Yarmouth are entitlement communities, meaning they get CDBG funds directly from HUD. The remaining towns may apply to the state to compete for CDBG funds. The CDBG Program, in addition to providing grants, also includes a loan program, "Section 108," which enables CDBG entitlement communities to borrow up to five times their annual entitlement grant. The entitlement community pledges current and future CDBG funds as security for the loan. Non-entitlement communities may also use this program but must do so through an agreement with the state. The maximum loan duration is 20 years.

US EPA NONPOINT SOURCE SECTION 319 GRANT PROGRAM

Under section 319 of the Federal Clean Water Act, US EPA annually provides grants to states for controlling nonpoint sources of pollution, such as agricultural runoff, mining activities and malfunctioning onsite septic systems. In Massachusetts these grants are administered by MassDEP. In states where onsite systems have been identified as a significant source of such pollution, the section 319 funds may be used to construct, upgrade or repair onsite systems.

US EPA STAR GRANTS

The Science to Achieve Results (STAR) grant program funds targeted research on environmental science and

engineering issues through a competitive process. The National Center for Environmental Research names areas of natural concern. At present, these centers focus on children's health, hazardous substances, particulate matter and estuarine and coastal monitoring. Those eligible for STAR grants include academic and non-profit institutions in the United States, as well as state, local and tribal governments.

POTENTIAL NEW REVENUE SOURCES

Much of this plan focuses on ways to lower the overall cost of reducing the impacts of nitrogen from wastewater, stormwater and fertilizer on coastal water quality. Still, the remaining costs are burdensome to the year-round population of Cape Cod. Having done its share to lower costs, the Cape now looks to alternatives to property taxes and fees to help finance the cost of preserving the economic benefits that a healthy Cape Cod provides to the rest of the Commonwealth. The Commission encourages implementation of additional funding sources to more fairly

LOCAL/REGIONAL: NITROGEN IMPACT FEES

New development located where it must rely on septic systems should participate in managing the nutrient loading problem on Cape Cod. This can be achieved by applying a nitrogen impact fee to new development dependent on traditional septic systems. The fee could be based on the amount of nitrogen generated by the development, and would internalize the cost of nutrient mitigation of the additional loads attributable to the property. The fee will encourage new development to locate in areas already served by wastewater treatment systems that remove nitrogen, an objective of the Regional Policy Plan. See the discussion on impact fees in Chapter 7 for more information.

Recommendation S6.3: The Cape Cod Commission shall evaluate the steps required for a regional or locally based nitrogen impact fee.

REGIONAL: SEPTIC TRUST FUND

A Septic Trust Fund should be established to optimally manage the maintenance, repair, and replacement of septic systems. In exchange for an annual fee, property owners served by traditional septic systems would have their systems regularly pumped out, repaired as needed, and replaced with a standard Title 5 system when necessary. The benefits of the program would be to extend the life of existing septic systems, lower overall replacement costs, optimize the treatment of septage by managing the timing of treatment at septage treatment facilities and relieve the homeowner from the high cost of replacement upon failure of their septic system.

Recommendation C6.4: The Cape Cod Commission shall develop a proposal for a Septic Trust Fund and pursue authorizing legislation.

REGIONAL: CAPE COD CAPITAL TRUST FUND

The Cape Cod Commission should identify and allocate resources to develop a revolving loan fund to finance infrastructure development on Cape Cod, particularly as it relates to water quality. A Cape Cod Capital Trust Fund for infrastructure financing should be established. The Trust Fund would be a regional entity with a professional staff experienced in public finance and would focus on providing funding for design and other aspects of infrastructure development not supported by other funding agencies at the state and federal levels. The Trust Fund would provide towns with additional funding at low interest rates to complete the design and construction of infrastructure needed to establish a sustainable economy on Cape Cod that does not negatively impact the environment and rectifies past negative impacts on the region's natural resources.

Recommendation C6.5: The Cape Cod Commission shall develop a proposal for a Cape Cod Capital Trust Fund for the financing of infrastructure design and construction.

STATE: WATER MIL CHARGE

One potential source of funding for wastewater infrastructure projects is an excise tax on water consumption, as recommended by the Massachusetts Legislature's Special Blue Ribbon Commission on Water

and Wastewater Infrastructure. An excise tax millage of one to three mils per gallon could be paid into a specific fund that could be used for necessary capital repairs and the replacement of aging infrastructure related to drinking water and wastewater (e.g. Title 5 Systems).

In the Boston Globe on April 13th, 2011, it was stated:

"Massachusetts has more than 20,000 miles of sewer and 21,000 miles of water pipes, and most of those pipes were installed more than 50 years ago… A draft… recommendation presented at yesterday's meeting [of the Special Blue Ribbon Commission] describes as a "good first step" a statewide surcharge of 1 mil per gallon — a mil equals one-tenth of one cent — on residential and commercial wastewater and drinking water.

Under the 1-mil scenario, the added cost per individual would be $23 per year, based on the state's goal for individual water consumption of 65 gallons per day."

If adopted by the state Legislature, a one mil charge would result in annual revenue of $81,993,600, based upon annual household water usage of 65 gallons per person per day and the total population on Cape Cod. Over 20 years, the excise would generate $1.64 billion, and $4.10 billion would be generated over 50 years.

This funding source is attractive as it is directly related to wastewater, and it discourages the excessive household use of water and should be pursued.

OTHER CONSIDERATIONS:

ALLOCATING COSTS IN SHARED WATERSHEDS

In shared watersheds, towns working together must agree upon a methodology to allocate costs. One approach may be to allocate costs proportionally to the share of nitrogen contributed to the watershed by each town. See Chapter 8 for a discussion on allocating responsibility, the requirement of Section 208 of the Federal Clean Water Act to designate Waste Management Agencies to take responsibility for nitrogen, and ways in which to collaborate.

ENVIRONMENTAL JUSTICE

Title VI of the Civil Rights Act of 1964 prohibits discrimination by recipients of federal financial assistance on the basis of race, color and national origin, including matters related to language access for limited English proficient (LEP) persons.

As federal financial assistance will be sought in support of this Section 208 Plan Update, it is incumbent upon the local and regional governments that may receive such assistance to have appropriate Title VI programs, including an effective Public Participation Plan. Outreach to all populations on planning decisions related to cost, affordability and the siting of potential technologies and infrastructure resulting from this plan, among other considerations, not only ensures compliance but can stimulate wider community discussion and acceptance of selected options.

The year 2014 marked the 20th anniversary of the signing of Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. Because of this legislation federal agencies are required to, "identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law." The order also directs each agency to develop a strategy for implementing environmental justice (EJ).

Key principles of environmental justice include:

- Avoiding, minimizing or mitigating disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority and low income populations; and
- Ensuring the full and fair participation by all potentially affected communities in the decision making process.

There are a number of designated environmental justice communities on Cape Cod. An area is described as an EJ area when the median household income of the census block group is equal to or less than 60% of the Barnstable County median household income, while also accounting for areas where 15% or more residents of Census block group identify as a race other than white.

In 2011, US EPA published Plan EJ 2014, the Agency's overarching strategy for advancing environmental justice. The Plan has three goals:

- Protect health and the environment in overburdened communities;
- Empower communities to take action to improve their health and environment; and
- Establish partnerships with local, state, tribal, and federal governments and organizations to achieve healthy and sustainable communities.

In overburdened communities, barriers can include lack of trust, lack of awareness or information, lack of ability to participate in traditional public outreach opportunities, language barriers and limited access to technical and legal resources. More transparency and dialogue can to lead to more meaningful engagement and participation of overburdened communities in the permitting process. More meaningful engagement, in turn, can lead to better permit outcomes for communities as well as permit applicants.

The planning and implementation of the Section 208 Plan Update will continue to facilitate outreach and participation in all aspects of the plan and permitting, and particularly as it relates to paying for the infrastructure necessary to meet water quality goals. While not every action may be legally required of regional and local governments as they pursue plan implementation, a robust outreach process is recommended as it leads to a more successful conclusion, as more participation leads to community acceptance of solutions chosen and implemented.

Recommendation S6.6:
Implementation of the Section 208 Plan Update shall include a local public participation process that includes efforts specifically designed to reach environmental justice communities.

Section 208 Plan Update Finance Model - A Tool for Towns to Utilize

As part of the Section 208 Plan Update, the Cape Cod Commission is providing communities with a model that will help them plan and manage the costs of building infrastructure to meet TMDLs for nitrogen in impacted watersheds. The Finance Model will be available to communities through the Commission's Watershed Team technical assistance program, described in Chapter 5.

PURPOSE

The model, developed by the Cape Cod Commission, AECOM Technical Services, Inc., and the Abrahams Group, estimates the total cost to build, finance and operate a proposed set of solutions and helps determine if the plan is affordable to the average household. The model is also designed to indicate if municipalities included in a proposed nutrient reduction scenario have the capacity to cover the total costs given current tax and borrowing restrictions. The model then allows users to select from a variety of potential revenue sources to determine how to best pay for the scenario proposed. This tool can assist in general policy discussions but is not a substitution for detailed financial planning.

MODEL STRUCTURE

The model includes three modules:

- Cost Module
- Financing Module
- Revenue Module

The Cost Module determines direct capital, operation and maintenance, and monitoring costs by individual technology. Financing costs are determined in the Financing Module, which allows users to select between various financing options appropriate for each technology solution included in the proposed scenario. The module then calculates the annual cost of a proposed scenario, including loan fees and interest payments. The final step is the Revenue Module, which allows users to select different methods to pay for the solution, including the financing costs. These modules are discussed in detail in the rest of this section.

COST MODULE

The Cost Module is based on cost estimates included in the Section 208 Plan Update Technologies Matrix (described in

Chapter 4), which is also the basis for the scenario building and decision support tools developed during the Section 208 Plan Update process.

This model will show capital costs by technology solution for any given scenario, which can be expected to include a variety of technologies selected by the user. Defining costs by individual technology is essential given the eligibility requirements of different financing programs and revenue sources. Land costs are not included in the total capital cost; however, the availability of municipally-owned land was a determinant in identifying potential sites for implementing technologies.

The model also includes the total operation and maintenance costs for the full scenario over time, as well as annual monitoring costs for each technology.

FINANCING MODULE

The Financing Module focuses on how money needed to build capital infrastructure will be obtained up front and paid for over time, which requires borrowing from state, federal and regional sources as detailed above. The model will allow users to select different borrowing options for different technologies included in proposed scenarios to allow for variability in financing eligibility and borrowing costs.

The model includes amortization tables for each type of SRF loan in order to calculate annual costs of the loan repayment process, including:

- SRF programs for clean water and drinking water; and
- USDA Rural Loan program.

The Financing Module also provides the ability to calculate debt service schedules and maturing principal and interest payments for conventional financing with general obligation bonds, including short-term bonds in anticipation of borrowing (BANs), long-term general obligation bonds and debt issuance costs.

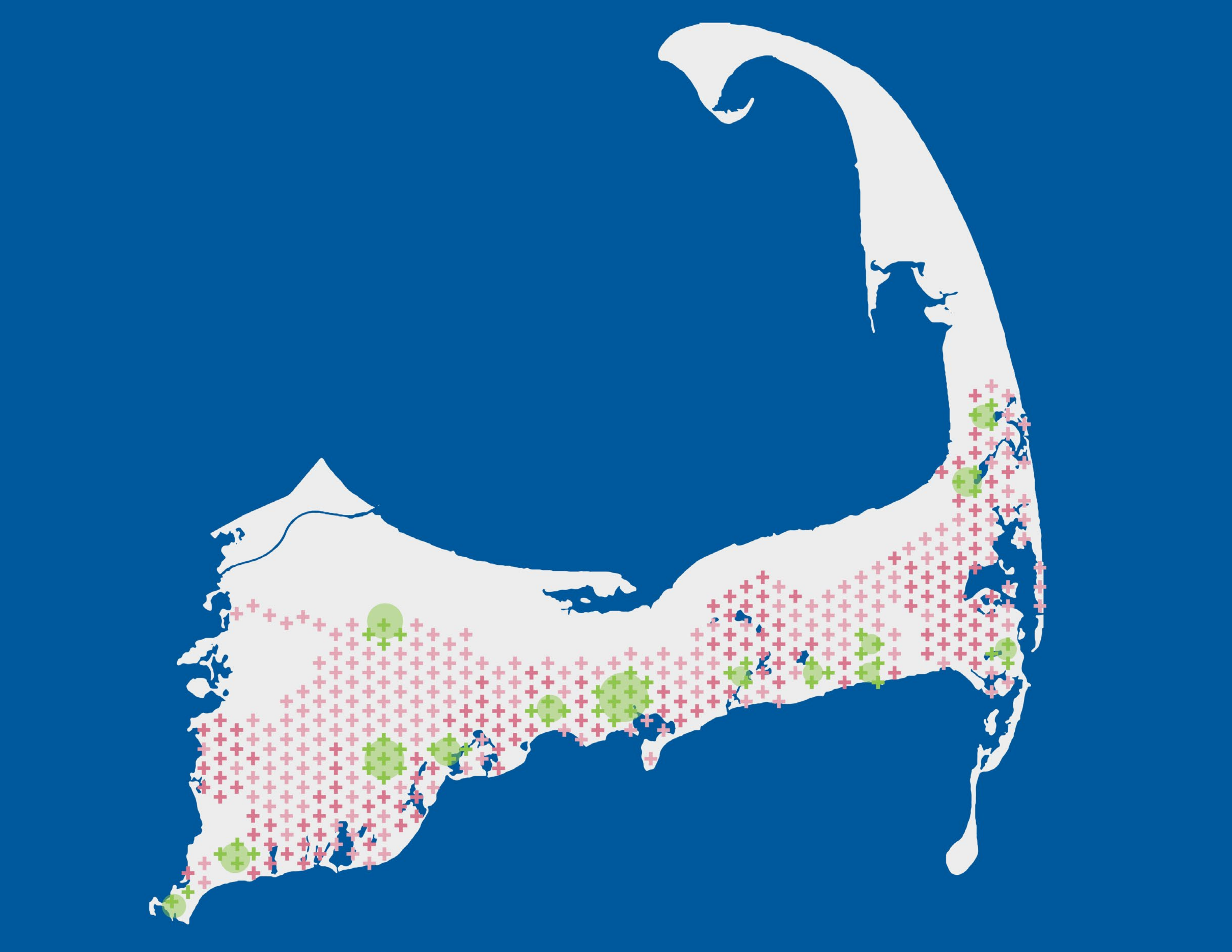
REVENUE MODULE

The Revenue Module will help policymakers assess the different options available for payment of the costs associated with the proposed set of technology solutions. The module allows the user to pick from the variety of funding sources described previously in this section. These range from general property taxes, to property tax betterments, to state or federal grants. The module is flexible to allow for the addition of new revenue sources as they become available.

07 BALANCE

Planning & Growth Management

Open space is one of the region's most valuable assets. Naturally forested open space also provides a valuable nitrogen "sink" as natural systems attenuate nitrogen contributions from atmospheric deposition. The rapid development pressure of the 1980s led to decreased open space and focused attention on the need to manage growth, guide land use, promote balanced economic growth, provide for adequate capital facilities and infrastructure, and protect environmental resources. Towns need to stimulate their tax base in order to afford the wastewater costs necessary to meet water quality standards and, at the same time, the economic development necessary to achieve that result is limited by the problem that needs to be solved. Without additional ability to treat wastewater, towns don't have the capacity for appropriate patterns of growth that don't add to the cost of remediating marine ecosystems.

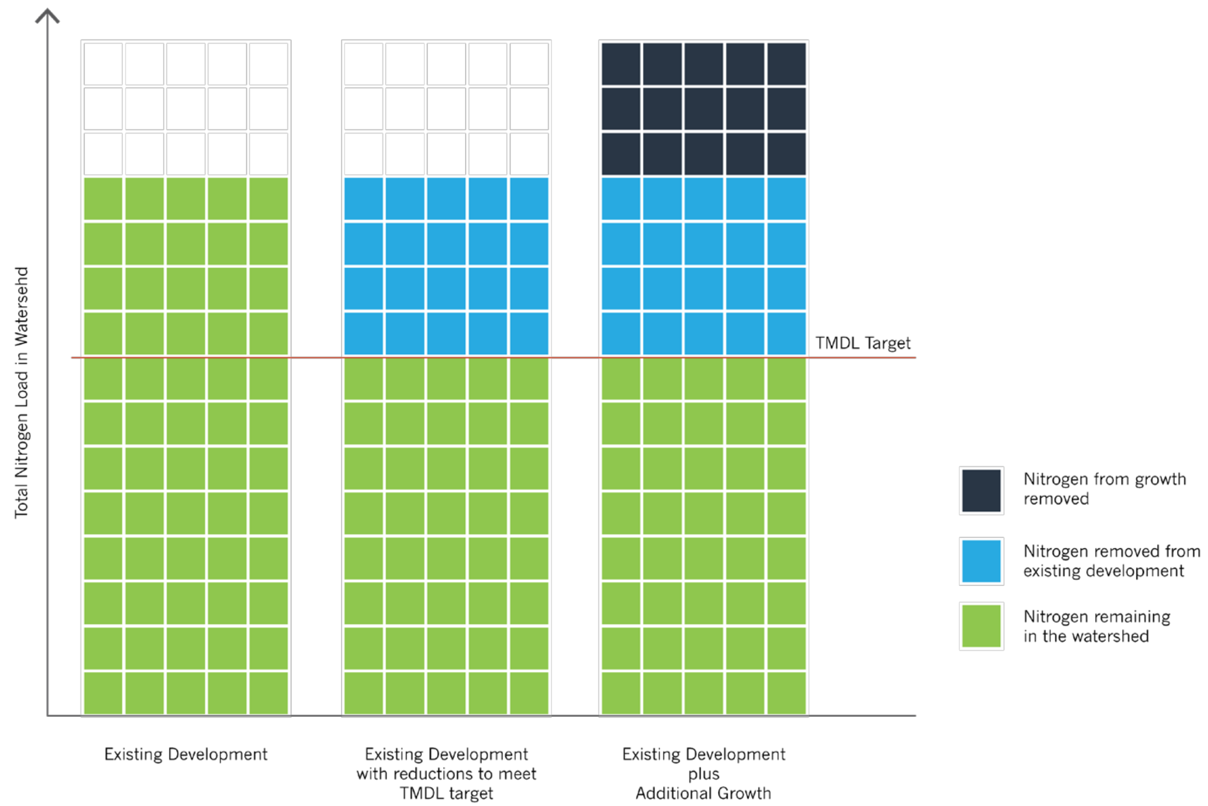


Managing Growth

Once nitrogen loads are sufficiently mitigated for existing development, 100% of the load from new development must also be mitigated in order to continue to achieve water quality goals (**Figure 7-1**).

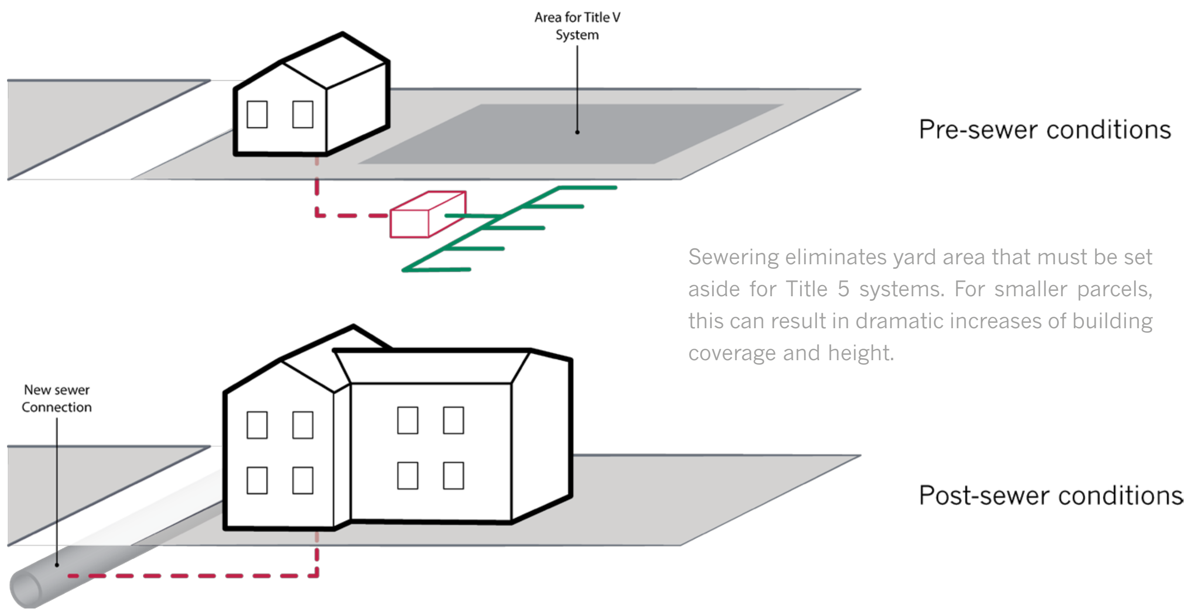
Projected growth can be significant in some towns and watersheds. The Cape-Wide Buildout Analysis to Support Regional Wastewater Planning was conducted by the Commission in 2012 with a grant from the Massachusetts Department of Environmental Protection (MassDEP).

Image on facing page: Cape Cod's water resources drive the regional economy. Development, or redevelopment, in watersheds to nitrogen impaired water bodies has the potential to further degrade water quality. Towns must continue to grow to promote a vibrant community. New growth has the potential to provide for a net nitrogen reduction if it occurs in places suitable for cost effective connection of existing properties to wastewater infrastructure.



100 Percent Future Nitrogen Removal

Figure 7-1



Sewer Induced Growth

Figure 7-2

The analysis identified the following potential municipal growth projections.

- Municipal residential growth for individual towns is estimated between 8% and 58% of new residential units. A Cape-wide average of 18% growth in additional residential units is projected.
- Municipal non-residential growth for individual towns is estimated between 8% and 163% of new square footage. A Cape-wide average of 53% of new square footage is projected.

The cost of addressing 100% of nitrogen from new growth can be substantial. "Estimating Cape-Wide Costs of Wastewater Infrastructure," a report dated March, 2013, identified additional costs of growth, assuming a 15% and 30% increase over current wastewater flows and assuming the construction of traditional wastewater infrastructure. That analysis showed that a 15% growth in wastewater flow translates to a 20% increase in capital cost. A 30% growth increases the capital cost by 40%. Because wastewater collection costs represent about 70% of the cost of constructing a system of sewers, treatment plants, and effluent disposal facilities, costs to mitigate nitrogen from new growth can be reduced by promoting density and discouraging sprawl (Cape Cod Commission 2013).

SEWER INDUCED GROWTH AND SMART GROWTH

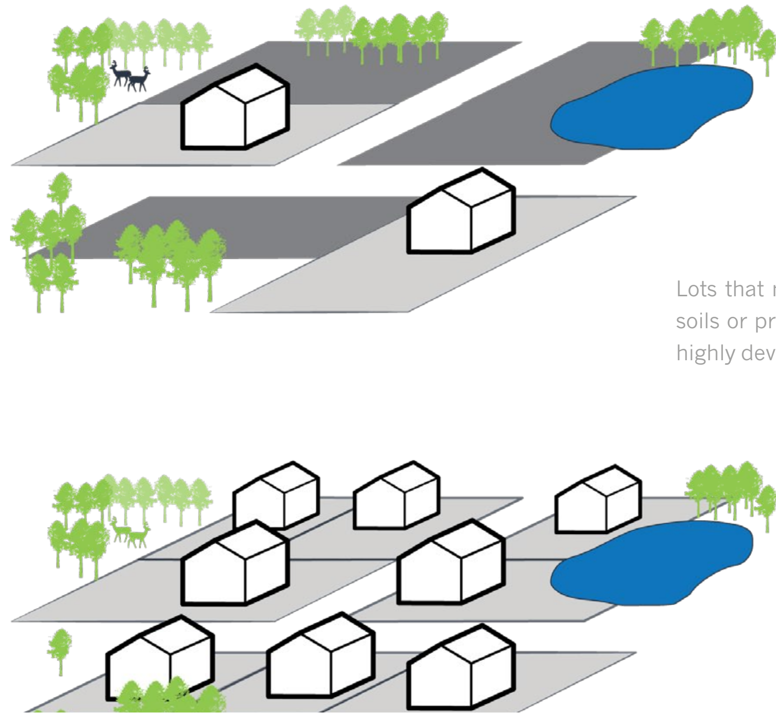
The Commonwealth of Massachusetts' Title 5 regulations for on-site systems can limit the amount of development on parcels where sewer or other wastewater treatment technology is not available. In some cases, property owners may not be able to add additional bedrooms or dwelling units allowed under zoning because the parcel relies on a septic system for wastewater management. Removing a parcel's septic system and connecting it to wastewater treatment lifts such as Title 5 restrictions and can result in additional development (**Figure 7-2**).

Both the Commonwealth and the Commission support well-planned growth to enhance community character, preserve high-quality open space, improve and support municipal budgets and improve impaired areas. To help reshape the development pattern on Cape Cod, measures must be taken to encourage mixed-use and compact forms of development (encouraging density) in existing centers and discourage sprawling development in sensitive areas. There are several ways in which this can be accomplished. First, the 2009 Regional Policy Plan (RPP) encourages mixed-use development in Economic Centers and infill in Villages as appropriate. To accomplish this, a Regional Land Use Vision Map (RLUVM) was created as the basis for such planning, helping to identify areas appropriate for

additional development and focusing on specific types of development, as well as those areas where such activity should be discouraged. As the Commission undertakes the five-year revision to the RPP in 2015, there is an opportunity to revisit the RLUVM to align desired future growth patterns with wastewater infrastructure planning. In addition, Cape Cod towns could change local zoning bylaws to support mixed-use and compact development. Finally, the state offers incentives to local governments that put policies in place to encourage such growth patterns. Areas that are eligible for the state incentives include:

- Areas near transit stations, including rapid transit, commuter rail, and bus and ferry terminals;
- Areas of concentrated development, including town centers, other existing commercial districts, and existing rural village districts; or,
- Areas that by virtue of their infrastructure, transportation access, existing underutilized facilities, and/or location make highly suitable places for residential or mixed-use smart growth zoning districts.

In the absence of Title 5 regulated septic systems, there is potential for uncoordinated and unplanned growth (**Figure 7-3**). A variety of regulatory and land use planning tools can be put in place at regional and local levels to manage growth in the absence of Title 5 and growth induced by sewers outside of defined growth areas. As towns move forward with local implementation of watershed-based plans and/or municipal wastewater management plans,



Increased Density as a Result of Proximity to Sewer

Figure 7-3

a combination of approaches will be needed to manage growth, meet community goals and protect natural resources and community character.

A review of Comprehensive Wastewater Management Plans (CWMPs) across the region shows that many of the areas targeted for collection systems do not always conform to growth center boundaries, and often extend well beyond what communities consider the boundary of a village or economic center. This overlap of nitrogen management areas with existing and desired growth patterns in Cape communities requires consideration of a combination of growth management tools to achieve water quality goals, while maintaining community character and preventing further sprawl and over-development. Such tools include: open space protection, transfer of development rights (TDR) sending and receiving districts, tax increment financing, checkerboarding, and zoning and regulatory changes. These and other planning and growth management tools are discussed further below.

The Section 208 Plan Update recommends that a range of technologies be considered at the watershed level. Those

that utilize a collection system and those that enhance natural systems or are located on-site all may play a role in remediation efforts. Communities may choose to construct sewer systems for a variety of reasons. The major objectives of collecting wastewater flows for treatment is to restore or protect the health of coastal embayments. In designing systems to achieve this important goal, communities need strategies to ensure that the location of collection systems does not facilitate growth patterns that threaten community character or encroach on habitat and natural resources. Additional considerations that should be addressed in designing systems include environmental issues such as failing Title 5 systems, drinking water issues, freshwater pond degradation due to phosphorus and the provision of infrastructure to support economic growth. There are several broad principles that communities should consider when coordinating community character goals with planning for sewer infrastructure:

- Coordinate watershed infrastructure planning to ensure that total maximum daily loads (TMDLs) are met and are met for current and future conditions. Sewer system capacity designed to meet TMDLs will take into account build-out within the entire watershed, even if the entire watershed is not sewered. This is because unanticipated growth outside the sewered area of a watershed with a TMDL could also result in increased nitrogen loading to the watershed. This additional growth could cause the watershed to exceed the level of total nitrogen from effluent consistent with TMDLs and require sewering of additional areas.
- Allocate limited collection system capacity to areas and uses that support broader community planning goals.
- Provide treatment capacity needed to achieve TMDLs through collection system design. In many towns there may be multiple system design alternatives that could meet that objective. One of the criteria used to select among alternatives should be how the collection system configuration would facilitate desired land use patterns in terms of the type, location or intensity of growth. Similarly, the selected alternative should not facilitate intensification of undesired growth. See also the discussion of "checkerboarding" sewer collection systems below.
- Ensure that community character and natural resources are protected or enhanced.

The 2009 RPP is currently being updated. Part of the RPP update includes the development of a decision support tool (Envision Tomorrow) that allows communities to test alternate land use scenarios, and instantly see the effects of their land use choices across a variety of criteria such as jobs, housing, transportation systems and the municipal tax base. Envision Tomorrow and other tools made available through the section 208 process will provide communities with valuable information to aid decisions about whether, and where, collection systems for sewers may be most appropriate.

OPEN SPACE PROTECTION

Open space is one of the region's most valuable assets. Naturally forested open space also provides a valuable nitrogen "sink" as natural systems attenuate nitrogen contributions from atmospheric deposition. Nearly 30% of the Cape's upland is currently protected as open space. This significant accomplishment can be attributed to foresight and investment by all levels of government: designation of the Cape Cod National Seashore in 1961 by the federal government; establishment of the 1,900-acre Nickerson State Park in Brewster and 700-acre Shawme Crowell State Forest in Sandwich; the approximately 15,000 acres within Joint Base Cape Cod protected as public conservation land since 2002; and protection of large town-owned conservation areas such as the 4,700-acre Sandy Neck Park in Barnstable, the 383-acre Beebe Woods in Falmouth, and the 800-acre Punkhorn Parklands in Brewster. In recent years, Cape communities significantly increased local land in conservation through smaller purchases, ranging in size from one or two acres to over 200 acres. Due in large part to the adoption of the Cape Cod Land Bank in 1999 and the Community Preservation Act in 2005 as local revenue sources for open space acquisition, Cape towns protected more than 4,000 acres of open space through strategic acquisitions of lands of conservation interest. Many Cape communities sought to protect significant natural and fragile areas and outstanding water resources, including lakes, rivers, aquifers, shore lands and wetlands.

Private land trusts play a vital role in land protection as well. Land trusts can serve as valuable intermediaries in preserving lands through less expensive means than

outright acquisition, such as accepting charitable donations or purchasing conservation restrictions. Private trusts are also valuable partners with towns in conserving key properties. Trusts are able to reach out to their membership and raise funds for acquisitions, a role that towns cannot perform.

Grants are also an important source of funds for acquiring land. The Cape has been fortunate in attracting significant outside funding in recent years through state, federal and private grants. This may be attributed to off-Cape recognition of the sensitivity of the natural resources on the Cape, and support for protecting cohesive habitats, recreation areas and water supply protection areas.

While growth management has not typically been the driving force behind open space acquisitions, it has become a significant side effect of conserving land. Future growth potential on the Cape has been managed or reduced through the dedicated efforts of governments and private organizations to permanently protect open space on Cape Cod. This Section 208 Plan Update recommends continued acquisition of protected open space to protect sensitive environmental areas, decrease potential for sprawl development, and maintain natural, forested areas that attenuate nitrogen contributions from atmospheric deposition.

CHECKERBOARD SEWER INFRASTRUCTURE

Prior to the passage of Section 10 of the Environmental Bond Bill in 2008, in the absence of special legislation, towns were required to connect all properties that had frontage along a sewer line. This law deprived towns the ability to identify areas that were and were not appropriate for future growth and redevelopment. In some cases, large vacant tracts of land with frontage, or parcels with redevelopment potential at significant densities, forced communities to design for more treatment and disposal capacity than they wanted, and subjected portions of the community to inappropriate growth. Since the passage of the Environmental Bond legislation in 2008, towns may adopt the provisions of the recently amended Massachusetts General Law (MGL) Chapter 83 to accomplish "checkerboarding." This authority allows communities to coordinate land use planning with planning for wastewater infrastructure in a way that supports smart growth development patterns. In order for a town to utilize the checkerboarding provision, it must have a MassDEP-approved wastewater management plan that clearly differentiates properties requiring sewering and those that do not.

FLOW NEUTRAL PLANNING

The passage of Section 5 of the 2008 Environmental Bond Bill provides towns access to State Revolving Fund (SRF) loans without interest for construction of wastewater infrastructure projects intended for nutrient management that meet certain criteria (Chapter 312 of the Acts of 2008).

The availability of zero rate of interest SRF loans is contingent upon a town's ability to demonstrate that sewers will not enable more growth than otherwise would be allowed under zoning and current wastewater regulations. For example, among the criteria required to access the zero percent SRF funds, a town must have adopted land use controls intended to limit wastewater flows to a level that would have been allowed under regulations in effect when the wastewater management plan was approved. These flows are calculated in the aggregate with flexibility to allocate flows for new growth and expansions of existing development. Flows associated with undeveloped and underdeveloped parcels can be allocated to areas identified for mixed use and compact development. Mandates for water saving devices can also accommodate new growth.

Consistent with the goals of the Environmental Bond Bill, towns should correlate land use planning with wastewater infrastructure planning examine zoning and land use regulations to ensure that sewers meet the resource protection and growth management goals of the community, and support growth where it is desired. Towns should also consider adopting sewer system checkerboard authority to implement growth management goals.

MassDEP has promulgated regulations (310 CMR 44.00) prescribing how towns should conduct a buildout analysis to demonstrate baseline flows, and requiring towns to provide proof of adoption of flow neutral land use controls. To date, Cape Cod towns seeking zero interest loans have adopted sewer and board of health regulations and bylaws limiting flows from new development and redevelopment. One example of such regulation is from Chatham, which adopted a sewer department regulation. The Chatham regulation limits existing structures to flows that existed prior to the development of sewer infrastructure. Flows from undeveloped parcels are limited to flows allowed by

Title 5 or Chatham Board of Health regulations. Variances for additional flows may be granted if allocated from the Chatham Sewer Bank by the Chatham Board of Water and Sewer Commissioners. Other Cape communities have adopted regulations allowing existing residential structures to add a bedroom or to add up to a maximum amount of flow upon connection to sewer.

LONG-TERM PLANNING

LOCAL COMPREHENSIVE PLANS

The Cape Cod Commission Act promotes the establishment of local planning committees in Cape towns to prepare, update and implement Local Comprehensive Plans (LCPs). Through the LCP and in consultation with the Commission, each town defines its vision for how to achieve the goals of the Act and articulates the town's growth policy. In addition, the LCP is an information source about existing and expected conditions. Implementation of an LCP through changes in local zoning or other actions can help a town manage growth and its impacts on local and regional resources, and to plan for and fund adequate infrastructure and capital facilities. Eleven of the 15 Cape towns have adopted LCPs that have been certified by the Commission as consistent with the RPP. Several towns are currently undertaking LCP updates or, in the case of Brewster, its first LCP effort. The LCP process provides an excellent opportunity for towns to create the vision and goals for managing growth on the local level.

LAND USE VISION MAPPING

The Commission has worked collaboratively with Cape Cod towns to develop a vision for the future of Cape Cod through adoption of local Land Use Vision Maps (LUVMs) that categorize Economic Centers, Villages, Industrial and Service Trade Areas, and Resource Protection Areas. The maps provide a framework for regional land use planning and identify discrete areas to focus future development activities as well as areas for additional protection. Towns with an endorsed LUVM may apply for flexible thresholds that trigger the Commission's regulatory review of Developments of Regional Impact (DRIs). The Land Use Vision Map is also a tool to encourage towns to consider zoning and other changes to guide growth toward desired areas that have infrastructure to support it and away from areas that have significant ecological or cultural resources that could be degraded by inappropriate development. To date, eight of the 15 towns on Cape Cod have adopted a LUVM with the town of Bourne partially designated. The 2015 update to the 2009 RPP will likely result in a further refinement of these growth and protection areas across the region.

GROWTH INCENTIVE ZONES

The Commission adopted Growth Incentive Zone (GIZ) regulations in 2005, establishing a process for directing development and redevelopment into areas with adequate infrastructure and away from sensitive resources areas. GIZs facilitate mixed-use compact development and redevelopment. By creating a master plan and providing infrastructure and mitigation strategies to accommodate development, a town can pursue reduced regulatory involvement by the Commission for projects proposed within the zone. To establish a GIZ, a town must first ensure that all growth is properly served by infrastructure. Towns may request modifications to existing DRI thresholds as part of the GIZ designation. To date, three GIZs have been designated by the Commission, including:

- Main Street Buzzards Bay - Bourne (2012)
- Route 28 Corridor - Yarmouth (2007)
- Downtown Hyannis - Barnstable (2006)

Downtown Hyannis is served by the Hyannis Water Pollution Control facility. Main Street Buzzards Bay is partially sewered and the town of Bourne has contracted to treat and dispose of a limited amount of wastewater in Wareham. Bourne is currently in the process of examining options for collection, treatment and disposal to bring additional wastewater capacity to Buzzards Bay to support new development and redevelopment.

ZONING

Zoning represents the primary tool for regulating land use. MGL Chapter 40A, the state's zoning act, enables cities and towns to establish zoning regulations designed to achieve broad purposes including protection of public safety and welfare, lessening congestion and encouraging the most appropriate use of land in a community. Municipal planning boards are responsible for land use planning and administration and are authorized by the zoning act to prepare zoning amendments for town meeting vote.

Through zoning bylaws, communities set forth development standards such as minimum lot size, maximum density, site coverage, setbacks, building height and other dimensional requirements. Zoning also controls what types of uses are permitted and where in order to minimize conflicts between uses and allow for the types of development desired by a community. Zoning is a powerful tool and has a significant impact on development patterns and character of a community. The adage "you get what you zone for" aptly characterizes the power of zoning regulations.

Municipal planning boards may draft revisions to the zoning bylaws to address development and land use issues. Adoption of proposed changes requires a two-thirds majority vote by a town's legislative body. While zoning changes are applicable to new development, the state zoning act provides extensive protections to legally established pre-existing uses or structures, including undeveloped subdivisions, allowing them to continue without meeting new zoning requirements. This tends to limit the extent and effectiveness of a zoning change. Pre-existing uses and structures may be required to meet new zoning when altered or expanded, depending on the requirements of the local zoning. Districts of Critical Planning Concern (DCPCs), authorized by the Cape Cod Commission Act, can eliminate the legal protections for pre-existing uses, structures and subdivision plans conferred under Chapter 40A.

OVERLAY DISTRICTS

The overlay district is a zoning tool that can be used for growth management. An overlay district lies "on top" of one or more zoning districts and establishes an area where certain growth opportunities or limitations are in effect. In addition to the dimensional and use limitations established by zoning, the overlay district can apply water quality standards for the purposes of drinking water protection or coastal water quality protection, or can identify economic development zones or growth incentive zones based on the presence of infrastructure or other features designed to support dense economic activity. Overlay districts also can be established for other specialized uses such as wireless towers, adult entertainment or medical marijuana.

On the Cape, most towns have adopted overlay districts to support resource protection. Examples include groundwater protection districts, floodplain districts, wildlife corridors, and coastal pond protection districts. Overlay districts can include additional permitting or review requirements, stricter performance standards, or outright prohibition of certain activities (i.e. use of hazardous materials). Several towns have also adopted overlay districts to support growth, including village center districts, revitalization districts, and growth incentive zones. Standards in these kinds of districts may require specific design features or amenities in exchange for allowing for increased density and flexibility in the dimensional requirements and mix of uses allowed.

DISTRICTS OF CRITICAL PLANNING CONCERN (DCPC)

As noted above, the DCPC is a powerful planning and regulatory tool that has been used by Cape communities to manage growth and protect sensitive resources. To date, a total of nine local DCPCs and two Cape-wide DCPCs have been designated with either implementing regulations or other regulations adopted by the towns or the Commission. A complete list of designated DCPCs is available in Appendix 7A.

The following are a few examples of DCPCs that have been adopted for growth management purposes.

- Brewster Water Protection DCPC: designated in July 2008 to protect "zones of contribution" (or watersheds) to public drinking water wells. The DCPC encompasses 6,538 acres in several areas: one in the southeastern part of Brewster, another in the southwestern part of town, and all land in Brewster that is within the Pleasant Bay Water Recharge Area. The DCPC has two purposes: a water resources district and a major public investment district. Watersheds within the DCPC include wellhead-protection lands for public wells in Brewster and for wells in Orleans, Harwich and Dennis. The four Brewster wells in the DCPC provide about 95% of the town's public water supply, and the remaining need is met mostly from private wells. Brewster has invested millions of dollars in the development and protection of the public drinking water supply wells within the DCPC. The Cape Cod Commission approved the town's proposed implementing regulations on October 1, 2009.

- Six Ponds DCPC (Harwich): designated in May 2000 to protect the water and natural resources and to manage growth over more than 1,200 acres of land and 110 acres of water in northeastern Harwich.
- Three Ponds DCPC (Sandwich): designated in February 2000 to protect water quality, preserve open space, and maintain the character of nearly 700 acres of land and more than 300 acres of water in southeastern Sandwich, this DCPC resulted in a reduction of residential development potential.

While prior district nominations have focused on natural resource protection, there are a variety of ways in which DCPCs may be instrumental in coordinating land use goals with infrastructure development to carry out local and regional goals. Reasons for potential DCPC designations might include:

- Coordination of major capital public facilities or areas of public investment,
- Economic development,
- Protection of cultural, scientific and recreational resources or,
- Natural resource protection.

A DCPC nomination may invoke a one year (18 months with extension) moratorium on the issuance of specified local permits within the nominated areas, thus providing a planning window to develop plans and regulations to meet community goals. Materials related to the process for establishing a DCPC are available in Appendix 7B.

There have been two Cape-wide Districts of Critical Planning Concern (DCPCs) designated to enhance the jurisdiction of Cape Cod communities. In response to the enactment of Chapter 262 of the Acts of 2012, Barnstable County established the Fertilizer Management DCPC by ordinance in September 2013. Chapter 262 of the Acts of 2012 vested exclusive authority over nutrient regulation in the Commonwealth (including regulation over fertilizer use and application) to the Massachusetts Department of Agricultural Resources (MDAR). The law contained certain exceptions to MDAR's exclusive jurisdiction, such as regulation adopted pursuant to the Cape Cod Commission Act. Development of the Cape Cod Pesticide and Fertilizer Use Inventory (see Appendix 7C) supported the need for special regulation in Barnstable County to protect Cape Cod's unique water resources. The Fertilizer DCPC designation allows towns to adopt and administer local turf fertilizer regulations.

The enactment of the Oceans Act of 2008, where the state legislature established the need for a state-wide ocean management plan, also inspired Barnstable County government to employ the DCPC tool to preserve jurisdiction and local control of our ocean resources. Barnstable County established the Ocean Management Planning DCPC in April of 2010, and the Cape Cod Commission adopted the Cape Cod Ocean Management Plan (CCOMP) in October 2011 (available at http://www.capecodcommission.org/ccomp). The CCOMP establishes goals, policies and actions to ensure protection of important natural, cultural and scenic resources in balance with certain limited development activities in the ocean. Later, Barnstable County government adopted regulations in the RPP, consistent with the DCPC purpose, to address off-shore sand mining and cable installations.

NATURAL RESOURCE PROTECTION ZONING

Natural Resource Protection Zoning (NRPZ) is a relatively new form of zoning that has been adopted in several towns in Massachusetts since 2009. It is a variation of a clustered subdivision, but with several enhancements. NRPZ preserves large areas of open space, concentrating all development in a small area. The number of allowed dwelling units is determined by a calculation that first eliminates the amount of important natural resource lands from the determination of the number of allowed units. The net acreage is then divided by the base density to determine the number of units. The base density is generally the same as allowed by the underlying zoning, but the number of units can be increased if the development includes public benefits such as affordable housing, wastewater treatment for the development itself as well as for other units, preservation of farmland, and other benefits to the larger community.

BULK AND BUILDING FORM REGULATIONS

Bulk and building-form regulations, also known as dimensional requirements, include lot size and coverage, building height and setbacks (or build-to lines). Towns can alter these regulations to encourage additional growth in a town center by relaxing height, lot coverage and/or

setback requirements. Conversely, towns can discourage future growth or redevelopment in other areas by tightening dimensional regulations.

Community character can be negatively impacted when small lots (6,000 square feet or less) are connected to wastewater treatment. Due to the size of these lots, removal of Title 5 setback requirements can create development options that are substantially different from limitations imposed by Title 5 (as shown in **Figure 7-2**). Towns should examine lot line setback requirements for small lots if they wish to limit the significant expansion of existing development on small lots. A more detailed discussion of these impacts is provided in the report entitled Sewers and Smart Growth: Challenges, Opportunities and Strategies (Ridley & Associates, Inc. 2009).

USE-RELATED REGULATIONS

Use regulations specify both the kind and intensity of activities that can take place on a given parcel. In communities seeking to promote a vibrant town center, a mix of residential and commercial uses can be allowed through modifications to use-related zoning provisions. This kind of regulation can also be used to encourage or restrict intensity of uses, depending upon the desired outcome.

TOWN CENTER ZONING

It has been difficult to invigorate traditional town centers on Cape Cod due to the lack of adequate wastewater infrastructure to support dense development, and zoning bylaws that were set in place decades ago did not support dense, compact development patterns. With the advent of sewers and other technologies, communities have an opportunity to rezone villages and town centers where additional growth is desired. Such rezoning can include dimensional standards that increase height and lot coverage and decrease setbacks, requirements to include mixed-use development, and support for public places and other pedestrian amenities, such as parking on the sides and rear of buildings. Rezoning to allow for denser, more compact development patterns may be balanced with other growth management measures outside of these areas to achieve local goals such as limiting sprawl to reduce wastewater infrastructure costs, preserving community character, and in some instances, for demonstrating "flow neutral" land development controls.

PROVINCETOWN GROWTH MANAGEMENT BYLAW

Provincetown adopted a Growth Management Bylaw in 1989. Its purpose is "both to maintain a level of development that will meet the needs of its current and future population without overburdening its natural resources or the capacities of public facilities, particularly the provision of potable water, wastewater disposal, and solid waste disposal, and at the same time encourage affordable housing and year-round economic development." The bylaw was adopted more than a decade before the town installed sewers, primarily due to the town's limited potable water supply. The metric for the Growth Management Bylaw is water usage (based on gallons per day Title 5 design flow), but it provides a model zoning (or other regulatory) framework for prioritizing future growth based on resource carrying capacity and for structuring permit allocation to encourage priority uses.

The bylaw limits new growth and expansion based on Title 5 flow. Applicants proposing development (new construction, expansion, change of use) that would result in an increase in Title 5 flow over the existing use must obtain a growth management "allocation permit." The permits are issued in accordance with Table of Use Categories and Priorities that establishes the order for how the pool of available gallons shall be allocated among different uses. The bylaw assigns a gallonage available to each category and the annual process for re-allocation of unused gallons within the use table. Applicants must "get in the queue" for an allocation permit if all available gallons for a particular use have been allocated for the year. The bylaw requires the town manager to provide an annual growth management report that reviews the year's gallonage allocations (as well as overall water usage and solid waste disposal data). Based on the findings of the report, the Board of Selectmen may revise the gallonage allocations for the upcoming year. Since the bylaw's adoption in 1989, voters at town meeting have approved several amendments and revisions to the mechanics of the bylaw and the priority of uses brought forth by the Planning Board, generally in response to fluctuations in the economy.

SLIDING SCALE LOT COVERAGE

In response to concerns about tear-downs of older homes and subsequent "mansionization," out-of-scale

development within the Cape Cod National Seashore, the town of Wellfleet adopted a zoning bylaw that limits lot coverage allowances based on a sliding scale. It provides a higher percentage coverage allowance for smaller lots, which decreases gradually as lot size increases. The bylaw also provides site plan review criteria and special permit review requirements for higher lot coverage.

The town of Barnstable adopted a similar type of sliding scale lot coverage limitation in the Craigville Beach district as part of the Craigville Beach DCPC implementing regulations. See previous discussion on DCPCs for more information.

The town of Provincetown also has a "scale bylaw" that is intended to preserve the existing scale of buildings in a neighborhood. It is an unusual example of a zoning bylaw that addresses and limits building volume. The intent of the bylaw is to preserve existing building scale by requiring all new structures and additions to comply with "appropriate" neighborhood scale. The Zoning Enforcement Officer directs the determination of each building's scale/volume based on a methodology set forth in the bylaw and calculates an average neighborhood scale. New structures and additions are limited to an increase/deviation from average scale of 25% or 15% within the historic district unless granted a special permit to exceed the allowance.

PAYING FOR NEW GROWTH

IMPACT FEES

An impact fee is a growth management tool used to help pay for the expansion of public infrastructure by requiring developers to pay their proportionate share of the costs. They are intended to help ensure that there is an adequate availability of public facilities and facilitate fiscally responsible growth. Usually charged when the occupancy permit is issued, impact fees can only be used to help offset the costs associated with that particular development. The funds cannot be charged to correct existing deficiencies in public facilities in the community at large.

The Section 208 Plan Update suggests that nitrogen budgets could be developed to better explain nitrogen cycling on Cape Cod. The following are suggested for inclusion:

- Nitrogen content in precipitation
- Watershed attenuation/denitrification
- Nitrogen loads to estuaries
- Food imports
- Fertilizer imports
- Atmospheric deposition

A comparison could be made between the existing nitrogen budget and a pre-development nitrogen budget to identify how nitrogen imports and natural attenuation capacity have changed over time. This effort would provide an overall picture of nutrient impacts on the region, including, in part, an assessment of nitrogen deposition from environmental and other non-controllable sources and could be used to form the basis for creating an impact fee system.

NITROGEN IMPACT FEES

One way to pay for new growth is through adoption of a nitrogen impact fee program. A nitrogen impact fee is a monetary charge imposed by a local government on new developments to recoup or offset a proportionate share of public costs associated with mitigating nitrogen pollution caused by that new development. In other words, a nitrogen impact fee shifts some portion of the financial burden to mitigate new nitrogen contributions from the public to the private sector. Impact fees take into account the direct capital costs required to accommodate new developments with wastewater infrastructure and, to the extent measurable, the costs of other negative consequences borne by the public. The result is to incorporate the full social and environmental costs of new development into the impact fee.

To withstand judicial scrutiny, impact fee systems must establish a rational nexus between the impact caused by the new development and the fee imposed to mitigate that impact. The Section 208 Plan Update sets forth the following guiding principles for establishing a nitrogen impact fee system:

- Any nitrogen impact fee must be based on the amount of nitrogen discharged from a property and any costs associated with mitigating its effects. Based on available data, it is possible to formulate

an equation that calculates nitrogen output by parcel by combining wastewater flow and lawn fertilizer run-off. Given existing state and federal statutes and recent legal challenges, the envisioned system would be best served by imposing a fee as a direct function of a parcel's nitrogen discharge, satisfying both "nexus" and "rough proportionality" standards of the courts (Koontz v. St. John's River Water Management District, 133 S. Ct. 2586 (2013)).

- Nitrogen pollution damages the environment and social welfare as a whole and its remediation increases infrastructure costs. To be fully effective, a nitrogen impact fee system should cover both direct and indirect costs, quantified in a manner that establishes a rational "nexus" for nitrogen output from development. An incentive system that does not account for the full cost of development could unintentionally incentivize over-development and consequently irreparably damage the environment and society (Rosenberg 2003).
- A nitrogen impact fee system should incentivize commercial and residential development and redevelopment in designated areas for growth based on community vision mapping process, and only in nitrogen sensitive areas with adequate wastewater infrastructure.
- The fee system needs to contain waivers based on affordability and monetary incentives for adoption of nitrogen-reducing technologies in new developments.

Nitrogen impact fees can be adopted by towns or on a regional level.

Cape Cod's current development incentive structure will continue to lead to over-development and degraded water quality from nitrogen pollution. Realigning development incentives, particularly through the use of nitrogen impact fees, can begin to remedy this situation.

Cape Cod towns make their own decisions about how much development to allow by adopting zoning and other land use regulations. To the extent that development has occurred or continues to occur without the benefit of wastewater treatment, there is a development threshold above which nitrogen harms the region's beaches and other tourist attractions. The region as a whole is dependent on tourism and recreational ecosystem services. Each town's individual development decision impacts not only its neighbors, but the long-term viability of the region. If a town allows unmitigated development, it receives a private benefit in the short-term by externalizing costs, such as nitrogen pollution, onto other towns in the region. In this situation, the long-term viability of the town and the region will be threatened by the degradation of the Cape's environment. In the long-term, limited development and the provision of wastewater infrastructure will maximize economic benefits for all towns.

A nitrogen impact fee system aims to include the complete social and environmental cost of a development into the developer's project cost, neutralizing private short-term benefits at the expense of long-term public costs. Several states are testing elements of a region-wide impact fee system. Eighteen states have implemented or intend to adopt variations of an impact fee for harmful externalities as part their growth management strategy. In addition, a form of "nutrient trading" is being considered for the Chesapeake Bay watershed, which includes portions of New York, Pennsylvania, Maryland, Virginia, West Virginia, Delaware, and Washington D.C. Lessons from these prior approaches have varying degrees of relevance and can be informative in future discussions across the Cape about nitrogen impact fee systems.

The next step in exploring the viability of implementing nitrogen impact fees is a discussion with Cape officials and stakeholders about the benefits and drawbacks of instituting local and/or Cape-wide nitrogen impact fees.

TAX INCREMENT FINANCING

Tax increment financing (TIF) creates a redevelopment district in which infrastructure improvements and/or project developments are financed based upon an anticipated future increase in property values. The idea is that the development improvements will eventually result in higher property taxes and therefore the financing "increment" is justified. TIF can be initiated either by a private developer or the municipality itself. Once the redevelopment district is determined, a base property value assessment is performed, and the revenue to agencies other than the redevelopment authority is "fixed" at a present-day amount. Any increase in tax revenue through increase in property value will accrue to the redevelopment authority. The TIF district is created for a set time period, usually between five and 30 years, and once the time period

ends, the increase in revenue from the property value increase reverts to the baseline taxing structure. For more information visit: https://www.planning.org/divisions/planningandlaw/propertytopics.htm.

TRANSFER OF DEVELOPMENT RIGHTS

Transfer of Development Rights (TDR) is a market tool communities can use to achieve land preservation. The preservation is accomplished by allowing one landowner to sever his/her development rights in exchange for compensation from another landowner who wants his/her development rights to increase. TDR programs transfer the development rights of a predetermined lot , known as a sending area, to another lot , known as the receiving area. Thus, while the development rights are reduced or severed on the sending area, increased density and development is allowed on the receiving area. The sending sites are typically deed-restricted so that only appropriate uses are allowed from the rights sale onward. TDR programs can be mandatory or voluntary. With mandatory TDR programs, the sending and receiving areas are pre-designated by downzoning the sending areas and decreasing the base density of the receiving areas so more development rights must be purchased in order to build at higher densities. With voluntary TDR programs, the sending areas are not downzoned. Instead, owners retain the option to receive payment for development on their property; these transferred rights are known as development credits. For more information visit: https://www.planning.org/divisions/planningandlaw/propertytopics.htm.

NUTRIENT REDUCING DEVELOPMENT

The development or redevelopment of property provides an opportunity to address wastewater treatment for the particular parcel under development, as well as the wastewater treatment needs of surrounding development. This solution removes both the new nitrogen generated by the new development and the existing nitrogen generated by existing proximate development, so that a net nitrogen reduction is realized in the area. This model can also be applied to existing developments, where one existing development has excess treatment and disposal capacity and allows another existing development to connect to their underutilized wastewater treatment infrastructure.

Two example projects that have been permitted on Cape Cod are Willowbend (Mashpee) and Red Brook Harborview (Bourne). The Willowbend project entailed construction of a nine-hole golf course expansion on Shoestring Bay. In addition to using an Integrated Pest Management Plan to minimize the use of fertilizers and chemicals, the project provided a nitrogen loading offset by connecting the neighboring Cotuit Bay Condominiums to the Willowbend Wastewater Treatment Plant. Willowbend paid for and constructed the sewer connection at no cost to the Cotuit Bay Condominiums resulting in a net reduction of 1,274 pounds of nitrogen per year to Shoestring Bay.

The Red Brook Harborview project is a mixed-use (residential and commercial) project that provides a village-scale wastewater treatment plant located on Red Brook Harbor in Bourne and was enabled by the Marine Commercial Overlay District zoning amendment. The bylaw allowed an increase in density (from four to 15 residential units) in exchange for an advanced wastewater treatment plant. The plant was oversized to treat wastewater from the adjacent Kingman Yacht Center, the 15 townhomes and up to 52 existing single family homes in the Cedar Point neighborhood. Upon buildout the project will result in a net reduction of 2,468 pounds of nitrogen per year to Red Brook Harbor. The wastewater treatment plant will be constructed and paid for by the private developer and made available to the neighborhood residents.

In general, the costs of this solution will be variable according to the technology employed. The cost to all involved parties will likely be reduced in relation to construction of separate, independent wastewater treatment works, by spreading the cost across more users in close proximity.

The performance and potential challenges of this approach will depend on the technology employed. In the past this approach has been employed by commercial development utilizing traditional infrastructure that has excess capacity to cover other new or existing development. Maintenance and monitoring responsibilities are typically established through private contractual agreements.

The benefit of this solution is the net nitrogen reduction in an area that is experiencing beneficial growth and development. The greatest challenge is that, under current regulations, this approach to addressing impacts from new development is voluntary and could be more complicated than addressing the on-site nitrogen generated by the new development. In order for this approach to be widely

used, incentives within the regulations would need to be developed. These could include density bonuses or reductions in other mitigation costs for non-nitrogen impacts. Current potential permitting agencies include: MassDEP, local departments of public works, boards of health, building departments, and the Cape Cod Commission.

The next step in exploring this approach is to initiate a discussion with Cape officials and stakeholders regarding potential regulatory amendments to promote sharing of private wastewater infrastructure to achieve net nitrogen reductions in nitrogen sensitive watersheds.

Planning Partnerships

Cape Cod is greater than the sum of its 15 towns. Because Wastewater Management Agencies will need physical domain over the lands and nutrient contributions they seek to manage, coordination with federal and state partners will be necessary to achieve water quality goals. Joint Base Cape Cod and the Cape Cod National Seashore are the largest of these state and federal land holdings, and they provide important open space and significantly reduced residential density and related nitrogen loads within their borders.

The Massachusetts Department of Transportation (MassDOT) state roadway system impacts coastal and freshwater bodies through stormwater runoff and tidal restrictions caused by state roadway bridge abutments and there is an opportunity to work cooperatively to address these issues. Federal, state and municipal governments and local land trusts play an important role through past and future open space acquisitions that prevent new development and protect water resources (see open space protection section above). Various federal and state programs are also available to assist the region as we implement water quality restoration measures.

JOINT BASE CAPE COD

RELATIONSHIP TO SURROUNDING TOWNS

At approximately 22,000 acres, Joint Base Cape Cod (JBCC), formerly known as the Massachusetts Military Reservation (MMR), is one of the largest contiguous properties in state or federal ownership on Cape Cod. There are four military commands operating on the base, including: the Massachusetts Army National Guard at Camp Edwards, the Massachusetts Air National Guard's 102 Intelligence Wing at Otis Air National Guard Base, the 6th Space Warning Squadron phased array radar site at Cape Cod Air Force Station, and the U.S. Coast Guard at Air Station Cape Cod.

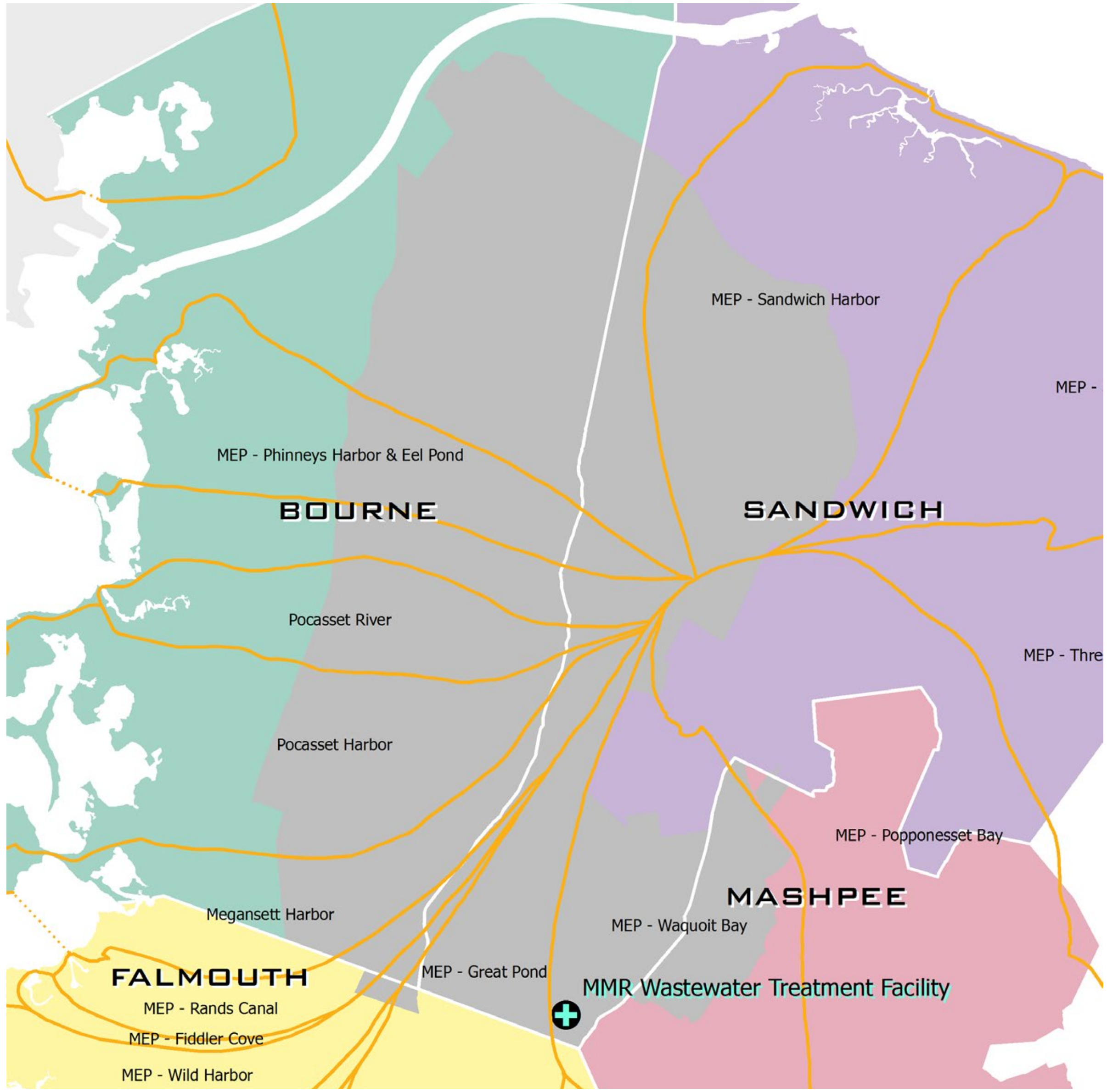
Camp Edwards, principally used for Army National Guard training, is comprised of approximately 15,000 acres in the northern portion of the base. The cantonment area, which is substantially more developed with structures, roads and other infrastructure, is comprised of approximately 7,000 acres in the southern portion of the base. JBCC includes parts of the towns of Bourne, Mashpee, and Sandwich, and abuts the town of Falmouth in Barnstable County, Massachusetts. The northern 15,000 acres of the base, also called the Upper Cape Water Supply Reserve, where the majority of the Army National Guard training occurs, was protected through a Memorandum of Agreement (MOA) and an Executive Order in 2001. The MOA was codified into law in 2002. Activities in the Reserve are subject to Environmental Performance Standards that were enacted to ensure the permanent protection of the Cape's drinking water supply and wildlife habitat in that area (Harshbarger 1998). The Environmental Management Commission ("EMC") of the JBCC consists of three members: The Commissioner of the Department of Fish and Game, the Commissioner of the Department of Conservation and Recreation, and the Commissioner of the Department of Environmental Protection. The EMC's responsibility is to ensure the permanent protection of the drinking water supply and wildlife habitat of the Reserve and to ensure all military and other activities in those 15,000 acres are consistent with the Environmental Performance Standards. The northern 15,000 acres contains four public water supply wells, three as part of the Upper Cape Regional Water Supply Cooperative and one as part of the Bourne Water District. The EMC is assisted by the Community Advisory Council ("CAC"), which consists of the following members: one each from Falmouth, Bourne, Sandwich and Mashpee; one family member resident of the JBCC; two representatives from the military; one from the Cape Cod Commission; one from the Wampanoag Tribe; one from the Upper Cape Regional Water Supply Cooperative; and five other at-large members. All members are appointed by the Governor.

STATUS OF JBCC WASTEWATER TREATMENT FACILITY

The 102nd IW is the host for utilities at JBCC, including the wastewater treatment plant (WWTP). Massachusetts DEP issued the 102nd IW a new discharge permit early in 2004 that authorizes an average 360,000-gallon per day discharge from the WWTP to enable it to accept a maximum 60,000-gallon per day sewage discharge from the new Barnstable County Jail and House of Corrections just north of Connery Avenue, in addition to wastewater from military installations. The location of the treatment facility is shown in **Figure 7-4**.

The MAARNG operates two facilities in the Reserve (Camp Edwards) with individual septic systems: Range Control and the Ammunition Supply Point (ASP). The US Air Force's Cape Cod Air Force Station also operates septic systems at their facility within the northern 15,000 acres. These discharges should be quantified and allocated to their appropriate watersheds.

The status of the 102nd's wastewater treatment plant is based in part on information contained in Appraisal Consulting Services for the Wastewater Treatment System at the MMR (Appraisal) completed in December 2012 by CH2MHill for MassDevelopment, a quasi-public state financing and development agency for the Commonwealth. Additional information was obtained from CWMPs either completed or currently in process by the four Upper Cape towns.



Joint Base Cape Cod, Surrounding Towns and Location of Wastewater Treatment Facility

Figure 7-4

The wastewater management system at JBCC was designed to provide wastewater collection, onsite treatment, and onsite disposal of treated wastewater from installation facilities. Wastewater is collected and conveyed by gravity and force mains to the WWTP located at the southern boundary of the base. Treated wastewater from the onsite WWTP is pumped through a 10.5 mile long effluent force main and disposed through rapid infiltration beds (RIBs), which are located on the northern boundary of the installation. The effluent force main and the disposal beds were constructed in 1996. The system was originally designed to allow biosolids from the WWTP to be composted and disposed of onsite as a soil amendment. Currently, wet biosolids are trucked offsite for disposal.

The general condition of the wastewater treatment plant was found by the CH2MHill report to be "fair" since it was upgraded in 1996 and underwent a number of part replacements in 2002. The report also noted the condition of the collection system was "cautious" since the collection system is over 50+ years old and no formal assessments have been completed. A 2001 inflow and infiltration study (I/I) indicated that I/I was a significant portion of the flow captured by the system.

The study reported that the replacement cost was $44 million, but that the replacement cost less depreciation was $16 million. The near-term and 20-year needs for JBCC users were reported as 140,000 and 147,000 gallons per day (gpd) respectively.

The study attempted to gauge the wastewater needs of the surrounding communities. This effort made use of the best available information from the towns to reflect existing and potential wastewater needs. The total short-term and future needs for treatment and total disposal are indicated in **Table 7-1** (excerpted from the study). Since the completion of the 2012 Appraisal, the Town of Mashpee filed a draft CWMP with the Massachusetts Environmental Policy Act (MEPA) Unit indicating a potential for treatment and disposal of 200,000 gpd of wastewater generated in the western portion of the town to be transported to and treated at the 102ndIW's WWTP.

ENTITY	NEAR-TERM NEEDS (GPD)	20-YEAR NEEDS (GPD)	REQUIREMENTS
JBCC Users	140,040	147,300	Treatment and Disposal
Town of Falmouth	200,000	200,000	Disposal only
Bourne Landfill	40,000	80,000	Disposal only
Town of Bourne	0	1,836,000	Treatment and Disposal
Town of Sandwich	156,000	630,000	Treatment and Disposal
Town of Mashpee	158,000	658,600	Treatment and Disposal
Total: Treatment and Disposal	454,040	3,271,900	
Total: Disposal Only	240,000	280,000	

Summary of Wastewater Treatment and Disposal Needs

Table 7-1

STATUS OF DISPOSAL SITE

Final treated effluent is pumped through a 10.5-mile ductile iron force main to four sand-lined RIBs located on the northern boundary of the JBCC south of Route 6 (Sandwich Road).

The effluent disposal system consists of the following components:

- Piping to distribute effluent to RIBs
- Four sand lined RIBs that cover approximately six acres
- Seven groundwater monitoring wells (three pairs downgradient, one upgradient)

The soil characteristics and design parameters for the treated wastewater disposal system are described in the Hydrogeologic Investigation and Design Effluent Infiltration Basins technical memorandum (CDM Smith 1993). Review of the hydrologic analysis indicates that the design capacity of the RIBs, according to Massachusetts Department of Environmental Protection (MassDEP) criteria, is substantially higher than the permitted flow to the WWTP. Based on the size of each infiltration basin and an assumed hydraulic conductivity that is typical of the Cape, the total

7

capacity of the four RIBs is approximately 907,000 gpd. With one RIB as reserve capacity, the disposal capacity is about 672,000 gpd.

JBCC JOINT LAND USE STUDY

The Cape Cod Commission completed an update to a 2005 JBCC Joint Land Use Study (JLUS) in October, 2013. Factors prompting the Army's re-nomination of JBCC for a JLUS were changes to missions on the installation due to the 2005 Base Realignment and Closure (BRAC) round, an increase in the training population using JBCC's ranges, and concern about the compatibility of future civilian land uses surrounding JBCC.

As demonstrated in the Appraisal discussed above, the WWTP and RIBs have sufficient capacity for existing and future (20-years) JBCC military wastewater needs. Those facilities also have excess capacity to treat and dispose of wastewater generated by non-military entities. Through the JLUS process, and based on the Appraisal, the JLUS identified the potential for a military/municipal partnership and shared services through municipal use of the excess capacity of the JBCC WWTP and RIBs for wastewater and landfill leachate disposal. The JLUS states:

Given the wastewater nutrient management needs of the region to achieve TMDL compliance and limited wastewater infrastructure on Cape Cod, it is a recommendation of this plan that existing capacity at the JBCC WWTP should be reserved for military and community needs.

The Office of Economic Adjustment (OEA), US Department of Defense provided funding for the JLUS update and provides funding for studies and preliminary design for potential shared infrastructure and services between military bases and surrounding communities.

JBCC MILITARY AND NON-MILITARY NITROGEN CONTRIBUTIONS

As stated above, there is sufficient wastewater treatment and disposal capacity for existing and future (20-years) military needs. The JBCC controls land within 13 watersheds that are shared with the towns of Bourne, Sandwich, Falmouth and Mashpee, as shown previously in **Figure 7-2**. The individual municipalities are responsible for planning and implementation to prevent violations of the Federal Clean Water Act. Because the JBCC controls land within watersheds that are shared with the towns, increases in the contribution of nitrogen from the JBCC within those watersheds will raise the bar for towns striving to meet TMDLs, and potentially increase the burden on municipal taxpayers.

While there is adequate treatment and disposal capacity for military uses, an unknown level of nitrogen contribution could result from non-military uses on the base. MassDevelopment has expressed an interest in promoting new development on the base with uses that do not compete with municipal economic development opportunities, and which are military-compatible. With these two caveats, this Plan supports the creation of new non-military uses that have proper wastewater treatment and disposal to ensure no net nitrogen impacts in nitrogen sensitive embayments.

To ensure equity and parity between the base and the surrounding towns, this Plan proposes further discussion and coordination between JBCC leadership, MassDevelopment and the Commission to establish a wastewater allocation policy for land uses within nitrogen sensitive watersheds that emanate from the base. Further, the military should ensure that future development within the cantonment area be connected to the JBCC wastewater treatment plant wherever feasible as recommended by the 2005 JLUS. Future agreements could also establish a protocol for allocating excess capacity at the WWTP and RIBs. The Commission is currently working to establish a new, proactive communications plan between the JBCC, MassDevelopment, the Commission, and the surrounding towns through a grant provided by OEA. The Commission has a webpage that provides comprehensive information on current and past plans and studies completed by the Commission regarding the JBCC, including the 2005 Joint Land Use Study and its 2013 update, as well as the MMR Master Plan Final Report, which includes background information on past environmental issues that led to subsequent planning processes. For more information, visit www.capecodcommission.org/jbcc.

Recommendation S7.1: The Cape Cod Commission shall continue discussion and coordination with JBCC and MassDevelopment regarding wastewater allocation policy for the base.

Recommendation S7.2: The Military should ensure that future development within the cantonment area be connected to the JBCC wastewater treatment plant wherever feasible.

STATE HIGHWAYS

STORMWATER MANAGEMENT

79% of the Cape's land mass is in a watershed to a coastal embayment. It is therefore not surprising that miles of municipal and state roadway run through nutrient impaired watersheds on Cape Cod (see **Figure 3-1** in Chapter 3). To varying degrees, stormwater runoff from these roadways contributes to the nutrient problems experienced on the Cape.

Through the MassDOT Impaired Waters Program (IWP), MassDOT has instituted a program to address roadway stormwater runoff draining to impaired water bodies. The program is part of the agency's compliance with its NPDES Phase II Small MS4 General Permit and commitments in an EPA enforcement letter dated April 22, 2010. Under the Program, "Impaired" water bodies are those listed as Category 4a or 5 in MassDEP's Integrated List of Waters (often referred to as the 303(d) list).

As currently proposed, MassDOT's IWP will include a methodology to assess water bodies covered by a nitrogen TMDL on the Cape. MassDOT is in the process of developing a methodology to assess stormwater contributions. This Section 208 Plan Update recommends future coordination of these assessment methodologies between MassDOT and the Commission.

Recommendation I7.3: MassDOT and the Cape Cod Commission should coordinate the methodologies for assessing stormwater contributions.

The Commission will review and comment on future NPDES regulatory filings and work with US EPA Region 1 regarding IWP methodologies adopted for the Cape. Due to the geology and hydrology of the Cape, it is recommended that Cape-specific Best Management Practices (BMPs) be developed for stormwater management in nutrient sensitive watersheds. Further discussion of specifically identified direct and indirect stormwater discharges to impaired water bodies is also recommended.

TIDAL RESTRICTION

Another area of cooperation is in the widening of coastal bridge abutments to improve tidal flushing in coastal areas where it is feasible and practical during roadway improvement projects. For example, MassDOT is proposing to replace an existing bridge over the Bass River between the Towns of Dennis and Yarmouth, associated with the Cape Cod Rail Trail extension. The existing bridge abutments constrict flow of the Bass River and are listed as a tidal restriction by the Cape Cod Atlas of Tidally Restricted Salt Marshes. The currently proposed bridge would increase the bridge opening to match upstream restrictions and would provide improvements to the hydraulics in the channel by increasing tidal flushing, decreasing channel velocities, and decreasing scour potential. Another example is the widening of the Muddy Creek bridge which is currently being undertaken by the towns of Harwich and Chatham.

To help address stormwater management issues within state highway layouts on Cape Cod, this Plan recommends the following:

- The Commission should work with the Cape Cod Metropolitan Planning Organization (MPO) to adopt policies that would require to the maximum extent practical design and construction of Cape-specific BMPs in Transportation Improvement Project (TIP) funded roadway improvement projects in the region. The Commission should also work with MassDOT through the IWP to identify Retrofit Projects to address specific roadway runoff issue affecting water quality in the area.
- The Commission should engage in discussions with MassDOT regarding the potential use of the state roadway right-of-way. These rights-of-way may present opportunities to permit, pilot and demonstrate non-traditional nutrient removal/remediation technologies, treated water effluent disposal, and water quality monitoring facilities that may be incorporated into state roadway design or constructed in existing roadway layout.

- The Commission and MassDOT should establish a data-sharing agreement to ensure that the best available infrastructure data is fully accessible to each agency.
- MassDOT should seek easements from public and private entities to accommodate the location, construction and maintenance of nitrogen reducing stormwater infrastructure where limited state road right-of-way would prohibit or complicate such location, construction or maintenance.

This Plan also recommends future coordination between MassDOT and the Cape Cod Commission to:

- Develop methodologies to assess stormwater contributions from state roadways,
- Identify opportunities to widen coastal bridge abutments to improve tidal flushing in coastal areas,
- Pursue improved data sharing between the two agencies.

The Cape Cod Commission will work with MassDOT through its IWP to identify Retrofit Projects to address specific roadway runoff issue affecting water quality. The Cape Cod Commission will comment on future NPDES regulatory filings by MassDOT with US EPA Region 1. Other areas of potential coordination include use of the state roadway rights-of-way for water quality improvement projects, and encouraging the use of easements from public and private entities on lands abutting state roadways to accommodate stormwater management systems.

Coordination between MassDOT and the Cape Cod Commission should be continued.

OTHER REGIONAL/STATEWIDE INITIATIVES

US EPA received $2 million in funding in FY14 to begin implementing the Southeast New England Coastal Watershed Restoration Program (SNEP). SNEP is a partnership among public and private stakeholders collaborating to create a broad ecological and institutional framework for protecting and restoring the coastal and watershed area spanning Westerly, RI to Pleasant Bay, MA. Nutrients, stormwater, and habitat restoration have emerged as key issues for this geographic area, and development of innovative or more effective approaches for managing them is a common priority. Those approaches that integrate habitat and water quality are of particular interest, as are projects that are transferable to the entire Region.

In FY14, the two National Estuary Programs (NEPs) - Narragansett Bay and Buzzards Bay - awarded $723,869 and $728,559, respectively, on behalf of SNEP to provide funding for projects in their study areas. See Chapter 4 for details on the projects that were funded.

The FY15 President's Budget includes additional funding for this Program - a total of $5 million for the region. Continued support for this program will allow Cape Cod communities to explore and pilot the non-traditional technologies and approaches identified in this plan that otherwise may not be possible through traditional local funding and financing. Cape Cod communities will have the opportunity to test the effectiveness of non-traditional technologies and approaches locally, continue refining the Technologies Matrix, and transfer that knowledge to other areas regionally and nationally.

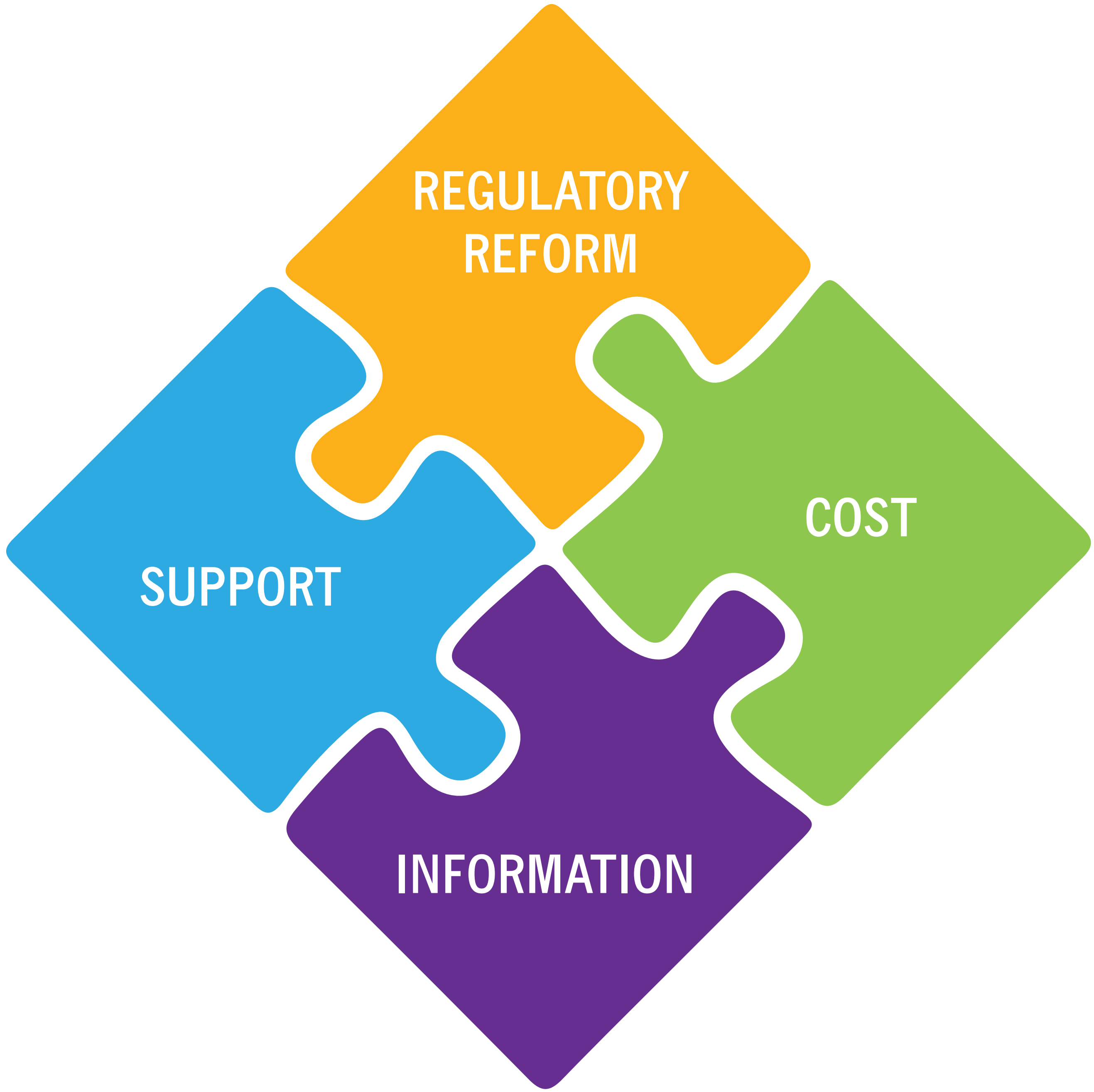
As part of the Section 208 Plan Update, the Commission suggests that US EPA continue its efforts under SNEP and encourage the continued expansion of the program moving forward.

Recommendation C7.4: US EPA should continue to expand the efforts of the SNEP program and encourage the continued expansion of the program moving forward.

08 IMPLEMENTATION

Recommendations

Cape Cod is experiencing a significant decline in our near-shore water quality that threatens not only our environment but also our economy. Many towns have been engaged in this discussion for years but action has been difficult. Regulations that drive and support efforts to solve our nutrient issues are focused on the jurisdiction of political subdivisions instead of the jurisdiction of the problem – watersheds. Available enforcement measures were developed with different pollution problems in mind.


REGULATORY REFORM
COST
SUPPORT
INFORMATION

Without action the future presents Cape Cod with a limited range of possibilities, the extremes of which are equally bad. Do nothing and we threaten our seasonal economy and watch as the property tax burden in every town migrates away from the coast and toward those whom can least afford it, an economic dislocation that will permanently disfigure the region, or wait for court mandated enforcement of currently available regulations that would come at great cost to Cape Cod homeowners and alone would not solve the problem.

The recommendations that follow are the result of 12 months of active community engagement. Collectively they represent a path forward that provides an opportunity to implement a responsible plan for the restoration of the waters that define Cape Cod.

The recommendations presented throughout this Section 208 Plan Update are restated here and grouped in four categories, outlining actions necessary to implement the plan update and restore water quality:

- Information (I)
- Regulatory Reform (R)
- Support (S)
- Cost (C)

Information

The course of action proposed in this document depends on information. The collection of data, the development of tools making data easier to use, and the analysis of water quality and wastewater technologies and policies create the framework for designing responsible watershed plans. The watershed scenarios created by adaptive nutrient management planning are dependent on a regional monitoring program that provides performance monitoring of selected technologies and policies and compliance monitoring measuring the collective effectiveness of permitted watershed nutrient reduction and removal strategies (**Monitoring I4.7**). In order to effectively monitor non-traditional technologies, this plan recommends that the Cape Cod Commission provide a technical guidance document that includes draft monitoring protocols for non-traditional technologies by September 2015 (**Monitoring Protocols I4.8**).

New information and data collected and learned through monitoring and research should be reflected in the Technologies Matrix. This Section 208 Plan Update recommends that the Commission develop a process for annual updates to the Technologies matrix (**Technologies Matrix Updates I4.1**). In addition, the Commission shall seek opportunities to sponsor an annual symposium to present and review new research on nutrient management technologies and approaches that coincides with regular updates to the Technologies Matrix (**Annual Technologies Symposium I4.2**).

The information collected should be housed in a regional water quality data center and made available to the public serving as a primary source for the continued research and development of water technologies and modeling. The creation of a data center will make sure the public is afforded the highest level of transparency regarding the information used as a basis for water quality policy and

associated capital planning (**WQ Data Center I4.10**). This information loop will enhance effective modification of Targeted Watershed Management Plans (TWMPs).

In addition, the Commission shall create a standing Monitoring Committee, to support implementation of the plan and identify and track developing issues, subject to available resources (**Monitoring Committee I4.9**).

This plan update also suggests continued cooperation and coordination with MassDOT in part to develop methodologies to assess stormwater contributions from state roadways, identify opportunities to improve tidal flushing in coastal areas and use rights-of-way for water quality improvement projects (**MassDOT I7.3**).

Lastly, in order to keep costs low and still meet water quality goals, a significant percentage of wastewater generation on Cape Cod will continue to rely on septic systems creating a demand for septage treatment. More information is needed and this report recommends an evaluation of the demands for septage processing and treatment (**Septage Treatment I4.4**).

Regulatory Reform

The existing regulatory framework for wastewater is better suited for permitting traditional facilities and needs to evolve to meet the challenges of diffuse, non-point source nutrient pollution. Changes are necessary to make it easier for communities and to better respond to the problem.

The MEPA process is generally the first hurdle encountered by communities planning wastewater programs requiring SRF funds. Process improvements recommended in this update create a streamlined Special Review Procedure for the review of TWMPs jointly by the Massachusetts Environmental Policy Act (MEPA) unit and the Cape Cod Commission (**SRP R3.6**). Targeted Watershed Management Plans, based on watershed boundaries, should be required. Minimum performance standards and guidance will be drafted and issued pursuant to this update within 90 days of its approval (**Targeted Watershed Management Plan R5.1**).

The Cape Cod Commission Development of Regional Impact review that typically follows the issuance of a MEPA certificate of adequacy from the Secretary of Energy and Environmental Affairs should be reformed, and a simpler and more supportive process to review Capital Developments of Regional Impacts (CDRIs) should be developed (**CDRI R3.5**). Local water quality management plans, and material changes to existing plans will be reviewed to ensure consistency with this update (**208 Plan Update Consistency Review R3.7**). Specific guidance on the consistency review shall be issued by the Commission within 90 days of this plan update approval (**208 Consistency Review Guidance R3.8**).

Additionally the collective responsibility of localities for nutrient loading should be updated and corresponding enforcement actions clarified. This update recommends the Massachusetts Department of Environmental Protection issue guidance outlining the process for watershed permits for nutrient loads (**Watershed Permitting R3.2**). This will allow communities more flexibility in designing efforts to comply with nutrient load limitations defined in the permit.

MassDEP should consider designating Nitrogen Sensitive Areas where watersheds contributing to waterbodies impaired by nitrogen are subject to a 208 Plan, where development primarily relies on septic systems, and/or where the water body is listed on the 303(d) list due to nitrogen overloading, and should modify available remedial actions to allow appropriate time for waste treatment management agencies to plan. (**Nitrogen Sensitive Areas R3.3**). The Commission also recommends that MassDEP eliminate the regulatory language establishing the presumption that Title 5 systems meet the state water quality standards in situations where it has been established that septic systems contribute to non-attainment (**Title 5 Presumption R3.4**). Given the importance of the federal Clean Water Act and the long-term commitment necessary to implement solutions to nutrient pollution on Cape Cod, the Commonwealth should seek delegated authority under the Clean Water Act to issue and enforce NPDES permits (**NPDES Delegated Authority to the State R3.1**).

Support

More direct support of local wastewater planning is warranted. This update recommends that local planning efforts consult with the Commission early in the process to ensure coordination between active watershed planning efforts and the Section 208 Plan Update. The Commission

shall provide technical assistance by assigning Watershed Teams to Waste Management Agencies (WMAs) and municipalities to support community planning efforts and to assist with decision support tools, permitting of technologies and financing (**Watershed Teams S5.3**).

These teams will assist in targeted watershed planning efforts and will advise on the development of watershed scenarios with nutrient management plans consistent with this Section 208 Plan Update (**Hybrid Watershed Planning Approach S5.2**). In conjunction with the watershed team approach, the Cape Cod Commission shall provide a detailed evaluation of effluent disposal options by September 2015 (**Effluent Disposal S4.3**). The watershed plans developed as part of the Section 208 Plan Update will also identify pilot projects and assist in identifying financial resources and direct support through a regional monitoring program. The Cape Cod Commission should establish criteria for eligible pilot projects (**Criteria for Pilot Projects S4.5**). In coordination with The United States Environmental Protection Agency (US EPA) and MassDEP, the Cape Cod Commission shall also work with communities, state and federal agencies to identify opportunities to implement pilot projects in suitable locations across Cape Cod (**Implementing Pilot Projects S4.6**). New development located where it must rely on septic systems should participate in managing nutrient loading. The Cape Cod Commission shall evaluate the steps required for a regional or locally based nitrogen impact fee (**Nitrogen Impact Fee S6.3**).

Additionally, this report recognizes the importance of third-party facilitation of intra and intermunicipal disagreements and recommends a process or guidance to manage disagreement among parties be developed in addition to the allocation of federal, state and regional resources for this purpose (**Managing Disagreement S1.1**). Implementation of the Section 208 Plan Update shall also include a local public participation process that includes efforts specifically designed to reach environmental justice communities (**Environmental Justice S6.6**).

This Plan also proposes further discussion and coordination with JBCC and MassDevelopment (**JBCC S7.1**) regarding wastewater allocation policy for the base, and also suggests that the military ensure that future development within the cantonment area be connected to the JBCC wastewater treatment facility wherever feasible (**Development in Cantonment Area S7.2**).

Cost

This issue of cost is paramount in considering the feasibility of proposed actions to restore Cape Cod's marine water quality. In addition to the existing efforts of the Cape Cod Wastewater Protection Collaborative in working with our legislative delegation to highlight the need for a broader base of financial support for wastewater treatment on Cape Cod, this report recommends that the Cape Cod Commission develop a proposal for a Cape Cod Capital Trust Fund for the financing of infrastructure design and construction (**Cape Cod Capital Trust Fund C6.5**). In addition, this plan recommends that the Cape Cod Commission develop a proposal for a Septic Trust Fund and pursue authorizing legislation (**Septic Trust Fund C6.4**).

Pursuant to the recently signed Water Infrastructure Bill, MassDEP should exercise its discretion in providing principal forgiveness up to 25% (**Principal Forgiveness C6.1**). The Environmental Bond Bill signed by the Governor in August 2014 makes available $4 million for monitoring programs and $4.5 million for pilot projects that are consistent with a current area wide water resource management plan adopted under section 208 of the federal Clean Water Act. This report recommends that the Commonwealth of Massachusetts make these and other funds designated for monitoring programs and pilot projects available to Cape Cod for efforts that are consistent with this Section 208 Plan Update (**Monitoring and Pilot Projects C6.2**). US EPA should also continue to expand the funding and piloting efforts of the Southeast New England Program (SNEP) and encourage the continued expansion of the program (**SNEP C7.4**).

Lastly, local targeted watershed management plans consistent with the Section 208 Plan Update should qualify for existing and potential revenue sources (**Access to Funds C5.4**).

Tools for Collaboration

The subregional stakeholder process associated with the Section 208 Plan Update identified three key categories of challenges to collaboration across town boundaries: who decides, who pays and who manages.

More specifically, "who decides" includes the following questions:

- Who decides which solutions to implement and when and how to reassess?
- How do two or more towns reconcile different levels of planning across town boundaries (including approved CWMPs)?
- How do two or more towns reconcile different town decision-making processes?
- Who decides the timeline required for building agreement?

"Who pays" includes the following questions:

- How do two or more towns coordinate different funding approval processes?
- How do two or more towns apply for and allocate off-Cape funding opportunities?
- How do two or more towns reconcile differences in willingness and abilities to pay?
- Who is financially responsibility for capital funding, operation and maintenance, monitoring, data management, and reporting?

And, "who manages" includes the following questions:

- Who is responsible for preparation of the watershed plan for permitting?
- Who builds, operates, maintains, monitors, and reports?
- Who is ultimately responsible for water quality outcomes?

Included in Appendix 8A is information on existing models that could be used by Cape Cod communities to address the challenges associated with who decides, who pays, and who manages. Existing models include intermunicipal agreements, federal/municipal public/public partnerships, independent water and sewer districts, water pollution abatement districts, districts of critical planning concern, regional health districts, and other potential models. Included is a discussion of the watershed conditions on Cape Cod where each may be most appropriate as a management structure.

Waste Treatment Management Agencies

Section 208 of the Clean Water Act requires the Commonwealth of Massachusetts to designate one or more waste treatment management agencies. As discussed below, these WMAs have specific responsibilities set forth by Section 208(c)(2)(A-I) of the Act, and include.

- to carry out the area wide waste treatment management plan;
- to manage waste treatment works and related facilities;
- directly or by contract, to design and construct new works, and to operate and maintain new and existing works as required by any plan developed pursuant to subsection (b) of this section;
- to accept and utilize grants, or other funds from any source, for waste treatment management purposes;
- to raise revenues, including the assessment of waste treatment charges;
- to incur short- and long-term indebtedness;
- to assure in implementation of an area wide waste treatment management plan that each participating community pays its proportionate share of treatment costs;
- to refuse to receive any wastes from any municipality or subdivision thereof, which does not comply with any provisions of an approved plan under this section applicable to such area; and
- to accept for treatment industrial wastes.

WMAs will need to not only build and operate technologies outlined in their watershed plans to achieve TMDL compliance, but also must have the capacity to issue bonds and notes to raise revenues to carry out their plans.

Given the shared nature of the water resources on Cape Cod, collaboration across town boundaries will be necessary to fulfill the requirements of Section 208.

The March 2015 submission to MassDEP of the Section 208 Plan Update set forth a process designed by the Cape Cod Commission for designating WMAs that included opportunities for local input on establishing responsibility and collaborating on shared watershed scenarios (see box below). See Appendix 8B for documentation of the process. The following amendment to this chapter provides details on the recommended designation and next steps.

DESIGNATING WASTE TREATMENT MANAGEMENT AGENCIES

Each of the 15 Cape Cod towns has been engaged, to varying degrees, in wastewater or watershed planning to date (see Chapter 2). Towns have traditionally been the responsible party for planning, design, construction and management of wastewater infrastructure and these efforts should continue. Each town has the ability to meet the requirements set forth in Section 208(c)(2)(A-I) of the Clean Water Act and are the appropriate entities to develop and implement local decisions regarding technology selection and placement.

WMA Designation Process

The Cape Cod Commission worked with town teams in a working group approach in a series of meetings, between March and June 2015, to get feedback on the designation of waste treatment management agencies (WMAs). Town teams consisted of town managers/administrators, staff, elected officials, and interested citizens. Five watersheds across Cape Cod were used for illustration and discussion around the following topics:

- Principles for establishing allocation of nitrogen responsibility
- Developing watershed scenarios
- Organizational and institutional structures

In June 2015, the Cape Cod Commission amended the 208 Plan Update to include the recommended WMA designations and implementation guidance.

Recommendation R8.1: The Cape Cod Commission recommends the Commonwealth of Massachusetts designate each of the 15 towns in Barnstable County as the WMAs responsible for implementation of the Section 208 Plan Update in the watersheds for which they are responsible.

WMAs are responsible for all of the nitrogen that enters the groundwater from land within their jurisdiction. A process for assigning nitrogen responsibility is described below. Parcels within the jurisdiction of Joint Base Cape Cod or the Cape Cod National Seashore are excluded from the town allocations, unless the parcel is assessed as residential, commercial or industrial.

ALLOCATING NITROGEN RESPONSIBILITY

Assigning Responsibility at the Subembayment Level

The Massachusetts Estuaries Project (MEP) establishes nitrogen thresholds, or the amount of nitrogen a water body can handle and still meet water quality goals, for each subembayment within the larger embayment systems they study. This is the best available information to identify nitrogen reduction targets for specific areas across Cape Cod. Therefore, it is recommended that responsibility for nitrogen reduction be assigned at the subembayment

watershed level. For watersheds that do not have a completed MEP technical report, the entire watershed area should be used.

Stormwater Coefficients

The stormwater coefficients account for driveways, structures, parking lots, and road frontage and the assumptions are as follows:

Residential:

- 2,000 sq. ft. home
- 500 sq. ft. driveway
- 40 ft. (width) road frontage

Non-Residential:

- 15,000 sq. ft. roof
- 30,000 sq. ft. parking lot
- 40 ft. (width) road frontage

Fertilizer Coefficients

The fertilizer coefficients account for lawn area and the assumptions are as follows:

Residential:

- 5,000 sq. ft. lawn

Non-Residential:

- 10,000 sq. ft. lawn

Start with the Unattenuated Controllable Nitrogen Load and Apply Attenuation Factors where Available

The controllable watershed nitrogen load is calculated on a parcel by parcel basis in three parts: wastewater, stormwater, and fertilizer. The wastewater load is calculated based on 90% consumptive use of the water used on each parcel. Nitrogen load from wastewater is calculated by applying the level of treatment associated with each parcel to the wastewater load (for example, septic systems treat to a level of 26.25 parts per million). To calculate both the stormwater and fertilizer loads constant coefficients for each are assigned to every parcel. These assumptions are derived from the MEP process and vary depending on whether the parcel is residential or non-residential. The stormwater and fertilizer coeffficients can be found in the box that follows.

These calculated nitrogen loads are source loads, prior to attenuation in the watershed (unattenuated loads). These unattenuated loads comprise a consistent Cape-wide data set that should be used as the starting point when considering nitrogen responsibility. The MEP technical reports document the ability of ponds and streams to attenuate nitrogen at a subwatershed level, but not all watersheds have the benefit of an MEP report at this time. Wherever a report is available, the attenuation factor should be applied to calculate the controllable load that reaches the water body.

Calculate Responsibility for the Existing Nitrogen Load based on Existing Attenuated Load

Existing attenuated nitrogen load takes into account the best available information without speculating about future development and addresses the problem existing development places on nitrogen overloaded estuaries. Each town's responsibility should be calculated based on its percentage contribution to the subembayment watershed's total controllable nitrogen load. The percentage contribution should be applied to the nitrogen reduction target to calculate the amount of nitrogen, in kilograms per year, for which a town is responsible.

Appendix 8C provides a complete breakdown of subembayment watersheds and nitrogen responsibility by town.

How to Address Growth

As the impact of future growth on attenuation in ponds, streams and other natural surfaces is unknown, projections of future nitrogen load responsibility should be based on unattenuated nitrogen loads.

Future nitrogen load projections are based on a Cape-wide buildout analysis. Future nitrogen responsibility, based on the potential for growth, should be calculated based on each town's potential contribution of nitrogen after buildout.

Data Updates and Local Modifications

The Commission is committed to utilizing the best available data and will update water use data, which is used to calculate wastewater flow and nitrogen load, at the parcel level at regular intervals, likely not to exceed five years. In addition, land use parcel data will also be regularly updated to reflect changes in development. All regular requests and data updates will be completed through the Commission's Strategic Information Office.

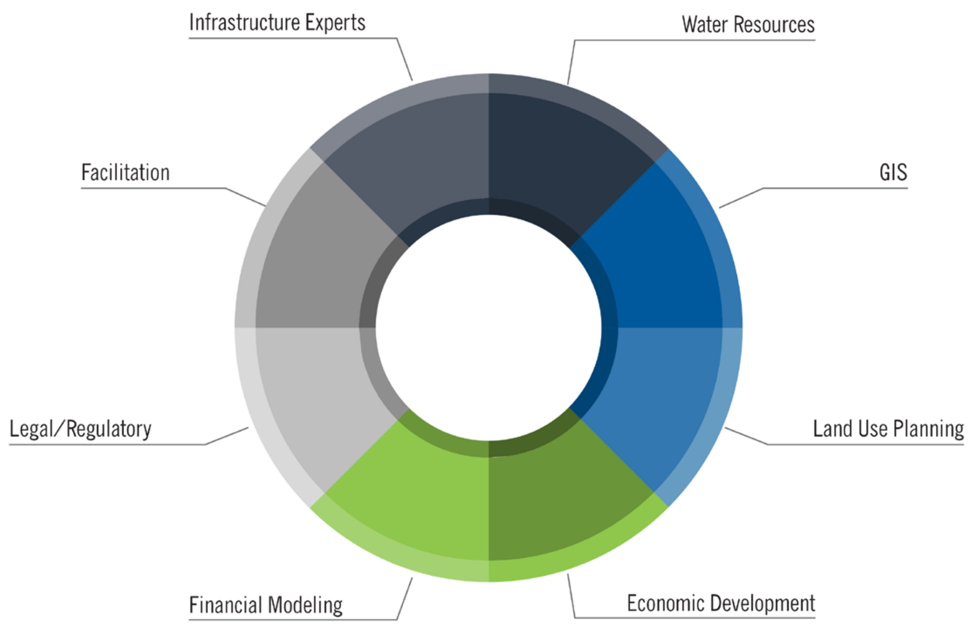
WMAs are encouraged to review the data presented in Appendix 8C and in WatershedMVP. If a WMA has better or more up to date data they will have the opportunity to provide updates to the database. Upon request of a Watershed Team, WMAs can request a data review and update. In addition, data reviews and updates will coincide with the five year incremental reviews associated with the adaptive management plan and the database will be updated as new monitoring data becomes available.

TIMEFRAME FOR IMPLEMENTATION OF THE 208 PLAN UPDATE

Upon certification of the Section 208 Plan Update by the Governor of the Commonwealth of Massachusetts, WMAs will have 12 months to develop "watershed reports" that outline potential scenarios for each of the watersheds for which they are responsible. At a minimum, these reports should include two scenarios that meet water quality goals in the watershed – a collection scenario, which relies completely on traditional collection and treatment, and a non-collection scenario which uses remediation, restoration, and on-site reduction approaches, with little to no collection and treatment.

The collection and non-collection scenarios form the outer bounds of an adaptive management plan. As time and resources allow, WMAs should also work toward establishing a design load that accounts for local non-nitrogen needs and fertilizer and stormwater reduction credits, as appropriate. Once collection and non-collection scenarios and the design load are established, WMAs should begin the development of a hybrid scenario that achieves the design load reduction and incorporates a range of both collection and non-collection technologies. Development of these high level scenarios will assist WMAs in discussions about how they can cooperate with neighboring communities in shared watersheds. A watershed report template is available in Appendix 8D.

In the event that a WMA does not develop a watershed report for a given area the Cape Cod Commission will issue a report based on feedback received in the watershed and



Technical Assistance Available Through Watershed Teams

Figure 8-1

subregional working groups described in Chapter 1 and pursuant to the watershed planning approach identified in Chapter 5. This report will stand as the WMA's plan for that watershed unless and until study is completed by the WMA and an alternate watershed report consistent with this 208 Plan Update is developed by the WMA.

Following this 12 month planning period the Cape Cod Commission will issue an implementation report describing the actions of WMAs to date.

Watershed Teams

The Commission is available to provide assistance to WMAs in developing watershed plans. As part of the process to update the 208 Plan the Commission developed watershed scenarios which will be shared with WMAs. As described in Chapter 5 and in **Figure 8-1**, Watershed Teams are available upon request and can assist WMAs in the areas of water resources, GIS, land use and economic development planning, finance modeling, legal/regulatory issues and consistency, infrastructure and technologies, facilitation, and consensus building. Upon review of the watershed scenarios developed by the Commission, a WMA may request a Watershed Team to assist with modifying the scenarios, as necessary. Specific teams will be provided based on the unique nature of the local planning and the type of assistance required and requested by the WMA.

Watershed Teams can provide training on decision support tools, coordinate local planning efforts with broader regional goals and assist in establishing consistency with local plans and the Section 208 Plan Update. This will be coordinated with the Capital Development of Regional Impact (CDRI) review, as described in Chapter 3, and WMAs that utilize a Watershed Team will receive the benefit of an expedited review based on consistency with the 208 Plan Update.

In watersheds where a Watershed Team is not requested, a 208 Plan Update consistency review in addition to typical regulatory review will be required. Guidance on this process, as described in Chapter 3, will be issued within 90 days of approval of the 208 Plan Update.

Establishing Watershed Associations

Community engagement will help move watershed scenarios, developed as part of the initial 12 month planning period, toward implementation. The process to update the 208 Plan focused on engaging the broader community from the outset, using new decision support tools that make complex data sets easier to understand. This approach involves more people and allows for better discussions and more informed local decisions.

WMAs are encouraged to coordinate with existing watershed associations and/or promote the formation of new associations early in the scenario planning process to ensure public support of the plans during implementation. As described in the proposed Special Review Process outline (Chapter 3) watershed associations might include:

- Elected and appointed municipal officials,
- Members of existing local committees,
- Representatives from the business, real estate, and environmental communities,
- A Cape Cod Commission representative,
- A traditional technology expert,
- A non-traditional technology expert,
- Interested citizens, and
- Representatives from Joint Base Cape Cod and the Cape Cod National Seashore, as appropriate.

These associations can serve as both advisors and ambassadors of local plans. The range of viewpoints represented will ensure closer coordination between plan development, local need and community values. Association members are representatives of the planning process and can share information with their constituents and broader social and professional networks, creating the potential for expanded public support for implementation of a preferred plan when one is established.

Principles for Resource Allocation

Chapter 2 outlines a process for prioritizing watersheds for study. Prioritizing watersheds for resource allocation and implementation requires additional considerations.

Once watershed reports have been developed and adopted by WMAs they should be assessed based on level of community support, including the level of collaboration and cooperation in shared watersheds, the potential for the plan

to facilitate information transfer around new technologies and approaches, estimated time to realize water quality improvements, and ongoing implementation of other capital projects. These considerations should be reviewed in addition to the nitrogen load and degree of impairment in the watershed.

Cost Savings of the 208 Approach

For over a decade Cape Cod towns have been struggling to solve the nitrogen problem and restore the health of our estuaries. Many towns have developed plans to provide wastewater infrastructure to homes and businesses and restore water quality in their embayments but few plans have been implemented. The capital costs of plans for just six of these towns range from $100-$700 million each totaling over $2 billion utilizing infrastructure better suited for urban areas with appropriate density and rate payers. Collectively these plans would remove less than half of the nitrogen necessary to meet water quality standards and do not address many less densely populated and more costly areas of the region.

The Regional Wastewater Management Plan (Cape Cod Commission 2013) estimates that it would cost between $4.2 and $6.2 billion to provide the source reduction necessary to remediate water quality problems in our embayments Cape-wide.

The 208 Plan Update process established an approach more suitable to the largely non-urban and seasonal nature of the communities on Cape Cod. The approach considered remediation and restoration approaches in addition to source reduction. It identified areas with suitable density for collection systems and identified land use characteristics associated with the appropriate use of watershed and embayment technologies, which may be implemented at a lower cost.

With this new approach comes a new challenge in financing. Remediation and restoration technologies must be supported in new ways, as those solutions may not have a defined rate base. Increasing environmental stewardship through information, education, and the development of local watershed associations should help address this challenge. Promoting community support of less expensive technologies, with the understanding that everyone benefits from healthy embayments, should increase support for cost sharing.

The development of this 208 Plan Update has resulted in ways to share the cost with State and Federal partners, who also benefit from healthy Cape Cod embayments. The region has seen an expanded time frame for zero interest State Revolving Fund (SRF) loans, the potential for principal forgiveness on SRF loans through the Environmental Bond Bill, and Federal funding for innovative nitrogen reduction projects through the Southeast New England Program (SNEP).

Based on the balanced approach set forth in this Plan Update, Cape Cod can implement appropriate source reduction, remediation, and restoration strategies for between $2 and $3.8 billion to meet water quality goals. This savings has been demonstrated locally through the development of a 208 consistent process in the town of Orleans, which is estimating a 40% savings over their original comprehensive wastewater management plan by adopting the approach set forth in this plan.

Lowering the cost of projects by considering collection and treatment in areas where it's most appropriate, broadening the use of remediation and restoration technologies, and sharing the cost with our partners results in a lower cost for Cape Cod residents and affordable scenarios for improving water quality.

Listing of Commonly Used Abbreviations:

3VS Triple Value Simulation

Act Cape Cod Commission Act

ANG Air National Guard

AOC Areas of Concern

ASP Ammunition Supply Point

BANs Bonds in anticipation of borrowing

BCDHE Barnstable County Department of Health and the Environment

BMP Best Management Practice

BRAC Base Realignment and Closure

CAC Citizen's Advisory Committee

CAC Community Advisory Council

CBI Consensus Building Institute

CCPEDC Cape Cod Planning and Economic Development Commission

CDBG Community Development Block Grants

CDRI Capital Developments of Regional Impact

CEC Contaminants of Emerging Concern

Collaborative Cape Cod Water Protection Collaborative

Commission Cape Cod Commission

CSO Combined Sewer Overflow

CWA Clean Water Act

CWMP Comprehensive Wastewater Management Plans

CWPC Comprehensive Wastewater Planning Committee

DBO Design-Build-Operate

DCPC District of Critical Planning Concern

DEIR Draft Environmental Impact Report

DIF District Improvement Financing

DRI Development of Regional Impact

EAC Equivalent Annual Cost

Abbreviations

EDA Economic Development Administration

EJ Environmental Justice

EMC Environmental Management Commission

ENF Environmental Notification Form

FEIR Final Environmental Impact Report

GIS Geographic Information Systems

GIZ Growth Incentive Zone

GPD Gallons Per Day

GRP Gross Regional Product

HUD Housing and Urban Development

I/A Innovative/Alternative

I/I Inflow and Infiltration

IMA Intermunicipal Agreement

IPCC Intergovernmental Panel on Climate Change

IUP Intended Use Plan Project Listing

IW Intelligence Wing

IWP Impaired Waters Program

IWRMP Integrated Water Resources Management Plan

JBCC Joint Base Cape Cod

JLUS Joint Land Use Study

LCP Local Comprehensive Plan

LEP Limited English Proficient

LID Low Impact Development

LUVM Land Use Vision Maps

MAANG Massachusetts Air National Guard

MAARNG Massachusetts Army National Guard

MassDEP Massachusetts Department of Environmental Protection

MassDOT Massachusetts Department of Transportation

MCL Maximum Contaminant Limit

MDF Maximum Daily Flow

MEP Massachusetts Estuaries Project

MEPA Massachusetts Environmental Policy Act

Abbreviations

Mg/L Milligrams Per Liter

MGD Million Gallons Per Day

MGL Massachusetts General Law

MMR Massachusetts Military Reservation

MOA Memorandum of Agreement

MOU Memorandum of Understanding

MPS Minimum Performance Standards

MS4 Municipal Stormwater Separate Storm Sewers

MVP Watershed Multi Variant Planner (Watershed MVP)

NEP National Estuaries Program

NPDES National Pollution Discharge Elimination System

NPS Nonpoint Source

NRPZ Natural Resource Protection Zoning

NSA Nitrogen Sensitive Area

O&M Operation and Maintenance

OA Ocean Acidification

OEA Office of Economic Adjustment

OWC Organic Wastewater Compounds

PAC Project Approval Certificate

PALS Ponds and Lakes Stewardship

PBDE Polybrominated Diphenyl Ether

PEF Project Evaluation Form

PFC Perfluorinated Compound

POTWs Publicly Owned Treatment Works

PPCP Pharmaceuticals and Personal Care Products

PPM Parts Per Million

PRA Project Regulatory Agreement

PRB Permeable Reactive Barrier

RIBs Rapid Infiltration Beds

RLI Regulatory, Legal, and Institutional Work Group

RLUVM Regional Land Use Vision Map

RPP Regional Policy Plan

Abbreviations

SAS Soil Absorption System

SBR Sequencing Batch Reactors

SIO Strategic Information Office

SMAST School of Marine Science and Technology

SNEP Southeast New England Program

SRF State Revolving Fund

STAR Science to Achieve Results

TAC Technical Advisory Committee

TDR Transfer of Development Rights

Technologies Matrix Water Quality Technologies Matrix

TIF Tax Increment Financing

TIP Transportation Improvement Project

TMDL Total Maximum Daily Load

TNMP Targeted Nutrient Management Plan

TOC Total Organic Carbon

Trust Massachusetts Clean Water Trust

UAA Use Attainability Analysis

UD Urine Diversion

US EPA United States Environmental Protection Agency

USCG United States Coast Guard

USDA United States Department of Agriculture

USGS United States Geological Survey

WMA Waste Treatment Management Agency

wMVP Watershed Multi Variant Planner (Watershed MVP)

WPCF Water Pollution Control Facility

WQM Water Quality Management Plan

WWFP Wastewater Facility Plan

WWTF Wastewater Treatment Facility

Advanced Wastewater Treatment
Wastewater treatment process that includes combinations of physical (AWT) and chemical operation units designed to remove nutrients, toxic substances, or other pollutants. Advanced, or tertiary, treatment processes treat effluent from secondary treatment facilities using processes such as nutrient removal (nitrification, denitrification), filtration, or carbon adsorption. Tertiary treatment plants typically achieve about 95% removal of solids and BOD in addition to removal of nutrients or other materials.

Aerobic
A condition where free oxygen is present.

Algae
Any organisms of a group of chiefly aquatic microscopic nonvascular plants; most algae have chlorophyll as the primary pigment for carbon fixation. As primary producers, algae serve as the base of the aquatic food web, providing food for zooplankton and fish resources. An overabundance of algae in natural waters is known as eutrophication.

Algal bloom
Rapidly occurring growth and accumulation of algae within a body of water. It usually results from excessive nutrient loading and/or sluggish circulation regime with a long residence time. Persistent and frequent bloom can result in low oxygen conditions.

Anaerobic
A condition where free oxygen is not present or is unavailable.

Aquifer
Geologic formations (rock, sand, or gravel) that are saturated and sufficiently permeable to yield significant quantities of water.

Area of Critical Environmental Concern (ACEC)
An area that receives special recognition by the state of Massachusetts because of the quality, uniqueness, and significance of the area's natural and cultural resources. Designation creates a framework for local and regional stewardship of critical resources and ecosystems.

Attenuate
To reduce the force, amount, or magnitude.

Benthic Regeneration
The regrowth of organisms on lake or sea floors.

Best Management Practices (BMPs)
Conservation practices to reduce non-point and point pollution from sources such as construction, agriculture, timber harvesting, marinas, and stormwater.

Biochemical Oxygen Demand (BOD)
The amount of oxygen per unit volume of water required to bacterially or chemically oxidize (stabilize) the oxidizable matter in water. Biochemical oxygen demand measurements are usually conducted over specific time intervals (5,10,20,30 days). The term BOD5 generally refers to standard 5-day BOD test.

Build-Out
The total of new development and redevelopment that is projected to occur over a planning horizon, typically 20 years.

Checkerboard Sewer System
A wastewater collection system configured to serve only selected properties in a neighborhood. Such a system allows a town to restrict sewer service to only those lots in greatest need, and/or to preserve limited capacity for wastewater treatment or disposal.

Glossary

Chlorophyll
A group of green photosynthetic pigments that occur primarily in the chloroplast of plant cells. The amount of chlorophyll-a, a specific pigment, is frequently used as a measure of algal biomass in natural waters.

Cluster Wastewater Treatment System
As used in this document, a wastewater collection and treatment system that serves more than one property and has a wastewater flow less than 10,000 gallons per day.

Coliform Bacteria
A group of bacteria that normally live within the intestines of mammals, including humans. Coliform bacteria are used as an indicator of the presence of sewage in natural waters.

Combined Sewer Overflows (CSOs)
A combined sewer carries both wastewater and stormwater runoff. CSOs discharged to receiving water can result in contamination problems that may prevent the attainment of water quality standards.

Commercial Water Use
Water used for motels, hotels, restaurants, office buildings, and other commercial operations.

Concentration
Mass amount of a substance or material in a given unit volume of solution. Usually measured in milligrams per liter (mg/l) or parts per million (ppm).

Comprehensive Wastewater Management Plan (CWMP)
A plan that identifies all the community's wastewater needs and problems, evaluates alternative means of meeting those needs, selects the most cost-effective and environmentally appropriate remedy, and proposes an implementation plan and schedule.

Constructed Wetlands
A type of wastewater treatment that mimics a natural wetland ecosystem in which water-loving plants filter wastewater and debris through their roots.

Consumptive Use
That part of water withdrawn that is evaporated, transpired, or incorporated into a manufactured product, or consumed by humans or animals, or otherwise removed from the immediate waterbody environment.

Contamination
Act of polluting or making impure; any indication of chemical, sediment, or biological impurities.

Denitrification
A process of transforming nitrate to nitrite to nitrogen gas, often mediated by microbial processes.

Design Flow
The amount of sanitary sewage, in gallons per day, for which a system must be designed in accordance with CMR 15.203. Design-flow criteria are the amounts of sanitary sewage that are assumed to be generated by a specific land use. For example, under Title 5, one bedroom is assigned a design flow of 110 gallons per day.

Direct Discharge
An area where groundwater discharges directly to open coastal water.

Dissolved Oxygen (DO)
The amount of oxygen gas that is dissolved in water. It also refers to a measure of the amount of oxygen available for biochemical activity in water body, and as indicator of the quality of that water.

Ecosystem
An interactive system that includes the organisms of a natural community association together with their abiotic physical, chemical, and geochemical environment.

Effluent
Sewage discharged into the environment, whether treated or not.

Embayment
A bay or a physical conformation resembling a bay.

Estuary
A partially enclosed body of water where fresh and salt water meet.

Eutrophication
A suite of changes in the condition of a water body that begins with excessive stimulation of growth of algae from nutrient inputs and leads to reduction in dissolved oxygen concentrations and sometimes to the death of organisms.

Floor Area Ratio (FAR)
A measure of building density calculated by dividing building square feet by lot area.

Flow Neutral Regulation
A sewer connection regulation that limits the amount of waste-water flow from a parcel to a pre-existing allowed flow.

Flushing Rate
The time it takes for an entire volume of water to be ex-changed, usually expressed in days or years.

Ground Water
Water below the land surface in a saturated zone.

Ground Water Discharge Permit Program
A Massachusetts regulation (314 CMR 5.00) that requires a permit for discharges of 10,000 gallons per day or more of pollutants to ground water.

Influent
Water volume flow rate or mass loading of a pollutant or other constituent into a water body or wastewater treatment plant.

Innovative/Alternative (I/A) Septic System
Any septic system or part of one that is not designed or constructed in a way consistent with a conventional Title 5 system. A conventional system has a septic tank, a distribution box or dosing mechanism, a soil-absorption system, and a reserve area. Some examples of alternative systems are recirculating sand filters, aerobic treatment units, peat filters, humus/composting toilets, and intermittent sand filters. Some I/A technologies are used to reduce nitrogen in nitrogen sensitive areas.

Interim Wellhead Protection Area (IWPA)
A public water system using wells or well fields that lack Massachusetts Department of Environmental Protection (DEP)-approved Zone IIs. The IWPA is a half-mile radius measured from the well or wellfield for sources with an approved pumping rate of 100,000 gallons per day or greater.

Loading, Load, Loading Rate
The total amount of material (pollutants) entering the system from one or multiple sources; measured as a rate in weight (mass) per unit time.

Glossary

Local Residence Time

The average time for water to migrate from a point in a sub-embayment to a point outside the sub-embayment.

Low Impact Development (LID)

An approach to land development (or redevelopment) that works with nature to manage stormwater as close to its source as possible. Includes principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treats stormwater as a resource rather than a waste product.

Massachusetts Estuaries Project (MEP)

A project of the Massachusetts Department of Environmental Protection (DEP) and the School for Marine Science and Technology at the University of Massachusetts, Dartmouth, that provides water quality, nutrient loading, and hydrodynamic information for 89 estuaries in southeastern Massachusetts. This information is combined in a linked watershed/estuary model that predicts the water quality changes that result from land use management decisions.

Massachusetts Groundwater Discharge Program

A state permit program to regulate effluent flows in excess of 10,000 gallons per day.

Milligrams Per Liter (mg/L)

A unit of measurement expressing the concentration of a constituent in solution as the weight (mass) of solute (1 milligram) per unit volume (1 liter) of water; equivalent to 1 part per million (ppm) for a water density. 1 g cm-3. 1 mg/L = 1000 ug/L; 1 g/L = 1000 mg/L.

Million Gallons Per Day (mgd)

Rate of water volume discharge representing a volume of 1 million gallons of water passing across a given location in a time interval of 1 day. A flow rate of 1 mgd = 1.54723 cubic feet per second (cfs) = 0.04381 cubic meters per second (cms).

National Pollutant Discharge Elimination System (NPDES)

A federal permit program under the Clean Water Act that regulates the discharge of pollutants into water bodies.

Natural Attenuation of Nitrogen

The naturally occurring retention or attenuation of nitrogen in wetlands or ponds.

Natural Resource Protection Zoning

A relatively new form of zoning that is a variation of a clustered subdivision, but with several enhancements. The number of allowed dwelling units is determined by a calculation that first eliminates the amount of important natural resource lands from the determination of the number of allowed units. The net acreage is then divided by the base density to determine the number of buildable units.

Nitrate

The nitrogen species in marine ecosystems that is most responsible for eutrophication, considered a broad indicator of contamination of ground water.

Nitrite

An intermediate oxidation state of nitrogen, between nitrate and ammonia.

Nitrogen

An element abundant in the atmosphere as dinitrogen gas. When combined with oxygen to form nitrate (NO_3), it can cause excessive algal growth in marine waters, which can lead to eutrophication.

Nitrogen Loading

The input of nitrogen to estuaries and embayments from natural and human sources.

Nitrogen Removal Credit

Under Title 5, an innovative alternative septic systems that achieves an effluent nitrogen concentration of 19 milligrams per liter for a residential property and 25 milligrams per liter for a commercial property may qualify for a Nitrogen Removal Credit. The credit allows for an increase in design flow per acre in designated Nitrogen Sensitive Areas such as Zone IIs to public water supply wells, in other areas that have formally been designated as Nitrogen Sensitive Areas, and for new construction in areas that have both private wells and on-site septic systems.

Nitrogen Sensitive Area

A Massachusetts regulatory designation of an area as particularly sensitive to pollution from on-site wastewater systems and therefore requiring nitrogen-loading restrictions; includes Interim Wellhead Protection Areas and Zone IIs of public water supplies, areas with private wells, and Nitrogen Sensitive embayments or other areas that are designated as nitrogen sensitive under Title 5, based on appropriate scientific evidence.

Non-Conforming Use or Structure

A use or structure that no longer conforms to current zoning, but did conform when first built or established.

Non-Point Source of Pollution

Pollution from many diffuse sources that is carried to surface waters by runoff or ground water. Non-point source pollution is typically caused by sediment, nutrients, and organic and toxic substances originating from land use activities and/or the atmosphere. Any source of water pollution that does not meet the legal definition of a point source.

Nutrient Loading

The introduction of excessive amounts of nutrients, such as nitrogen or phosphorus, from wastewater or fertilizers, which ultimately reach ponds or estuaries.

Nutrient Management Regulations

Regulations that establish limits on the amount of flow from on-site septic systems serving new development and redevelopment or use changes.

Nutrients

Any substance required by plants and animals for normal growth and maintenance; for example, nitrogen and phosphorus.

On-Site Treatment and Disposal System

A natural system or mechanical device used to collect, treat, and discharge or reclaim wastewater from an individual dwelling without the use of community-wide sewers or a centralized treatment facility. It includes a septic tank and a leach field.

Organic Matter

The organic fraction that includes plant and animal residue at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population. Commonly determined as the amount of organic material contained in a soil or water sample.

Organic Nitrogen

Organic form of nitrogen bound to organic matter.

Outfall

Location point where wastewater or stormwater flows from a conduit, stream, or drainage ditch into natural waters.

Glossary

Outstanding Resource Waters
A Massachusetts Department of Environmental Protection (DEP) designation assigned to certain water bodies based on their outstanding socio-economic, recreational, ecological, and/or aesthetic values.

Oxygen Demand
Measure of the dissolved oxygen used by a system (microorganisms) and or chemical compounds in the oxidation of organic matter. See also biochemical oxygen demand.

Oxygen Depletion
Deficit of dissolved oxygen in a natural waters system due to oxidation of natural and anthropogenic organic matter.

Parts Per Million (PPM)
Measure of concentration of 1 part solute to 1 million parts water (by weight). See milligrams per liter.

Pathogen
An agent such as a virus, bacterium, or fungus capable of causing disease.

Permeable Reactive Barrier (PRB)
A carbon-containing reactive substance that promotes denitrification.

pH
A measure of acidity indicated by the logarithm of the reciprocal of the hydrogen ion concentration (activity) of a solution. pH values less than 7 are acidic; values greater than 7 are basic; pH of 7 is neutral. pH of natural waters typically ranges from 6-8.

Phosphorus
A nutrient essential for plant growth that can play a key role in stimulating the growth of aquatic plants in streams, rivers and lakes.

Phytoremediation
The use of plants to take up nutrients, contaminants, or other substances from soils, ground water, and surface water in order to restore ecosystem health.

Point Source of Pollution
As defined by the US Environmental Protection Agency (EPA), any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

Pollutant
A contaminant in a concentration or amount that adversely alters the physical, chemical, or biological properties of a natural environment. The term include pathogens, toxic metals, carcinogens, oxygen demanding substances, or other harmful substances.

Publicly Owned Treatment Works
Municipal wastewater treatment plant owned and operated by a (POTW) public governmental entity such as a town or city.

Public-Supply Withdrawals
Water withdrawn from surface water or groundwater by public or private water suppliers for use within a community. Water is used for domestic, commercial, industrial and public water uses such as fire fighting.

Recharge
The return of water to an underground aquifer by natural or artificial means.

Residence Time
The average time required for a particle of water or a pollutant to migrate through an estuary.

Salinity
The measure of the salt content of water. ,measured by weight as parts per thousand (ppt). Salinity concentrations range from 0.5-1 ppt for tidal fresh waters; 20-25 ppt for estuarine waters; 30 ppt for coastal waters to 35 ppt for the open ocean.

Secchi Depth
A measure of the light penetration into the water column. Light penetration is influenced by turbidity.

Septage
Material physically removed from any part of an on-site system, including, but not limited to, the solids, semi-solids, scum, sludge, and liquid contents of a septic tank, privy, chemical toilet, cesspool, holding tank, or other sewage waste receptacle. It does not include any material that is hazardous waste.

Septic Tank
A buried tank designed to receive and pre-treat wastewater from individual homes or facilities by separating settleable and floatable solids from wastewater. It is one component of an on-site wastewater treatment and disposal system.

Setbacks
A zoning term used to refer to the distance between a building and property lines.

Sewage
The water-carried human or animal wastes from residences, buildings, industrial establishments, or other places, together with such ground water infiltration and surface water as may be present. The liquid and solid waste carried off in sewers or drains.

Sewer
An artificial, usually underground, conduit for carrying off sewage or rainwater.

Sewerage
The removal of wastewater and refuse by means of sewers.

Sewershed
The properties within the area of service of a sewer system.

State Revolving Fund (SRF)
A Massachusetts program that helps with the financing of water pollution abatement projects. Two types of funding are provided through this program: the Clean Water and Drinking Water State Revolving Fund grants.

Station (Monitoring)
Specific location in a waterbody chosen to collect water samples for the measurement of water quality constituents. Stations are identified by an alphanumeric code identifying the agency source responsible for the collection of the data and a unique identifier code designating the location. Station measurements can be recorded from either discrete grab samples or continuous automated data acquisition systems. Station locations are typically sampled by state, federal or local agencies at periodic intervals (e.g., weekly, monthly, annual etc.) as part of a routine water quality monitoring program to track trends. Station locations can also be sampled only for a period of time needed to collect data for an intensive survey or a special monitoring program.

Stormwater Runoff
Rainfall and snow melt from diffuse (non-point) sources such as roofs, roadways, driveways, and other impervious surfaces.

Glossary

Sub-Embayment
A cove within an embayment.

Surface Waters
Water that is present above the substrate or soil surface. Usually refers to natural waterbodies such as streams, rivers, lakes and impoundments, and estuaries and coastal ocean.

System Residence Time
The average time for water to migrate through an entire estuarine system.

Tidal Flushing
The exchange of water from an estuarine system to the water body into which it empties.

Title 5
A Massachusetts state regulation (310 CMR 15.00) governing the siting, construction, inspection, upgrade, and expansion of on-site sewage treatment and disposal systems and the transport and disposal of septage.

Total Coliform Bacteria
A particular group of bacteria that are used as indicators of possible sewage pollution.

Total Maximum Daily Load (TMDL)
The greatest amount of a pollutant that a water body can accept and still meet water quality standards for protecting public health and maintaining the designated beneficial uses of those waters for drinking, swimming, recreation, and fishing.

Transfer of Development Rights (TDR)
A land use regulation that allows development rights to be transferred from an area where additional development is not desired, to an area where additional development is desired.

Wastewater Flow
The wastewater from septic systems that leaches into groundwater and flows through ground water into receiving waters such as a pond or estuary.

Waste Load Allocation (WLA)
The portion of a receiving water's total maximum daily load that is allocated to one of its existing or future point sources of pollution.

Wastewater Treatment
Chemical, biological, and mechanical processes applied to an industrial or municipal discharge or to any other sources of contaminated water in order to remove, reduce, or neutralize contaminants prior to discharge to a receiving water.

Water Pollution
Any condition of a waterbody that reflects unacceptable water quality or ecological conditions. Water pollution is usually the result of discharges of waste material from human activities into a waterbody.

Water Quality
Numerical description of the biological, chemical, and physical conditions of a water body. It is a measure of a water body to support beneficial uses.

Watershed
An area of land that drains to a common receiving body of water.

Zone I
The protective radius required around a public water supply well or wellfield.

Zone II or Zone of Contribution

The area of an aquifer that contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at approved yield, with no recharge from precipitation).

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